A publication of the International Society for Horticultural Science

Chronica Horticulturae

Horticultural highlights

Which distribution strategy will support new exclusive apple varieties: club, trademark, or free production? • Breeding of three Andean fruit crops in Ecuador • Sustainable irrigation of date palms in the hyper-arid United Arab Emirates: a review

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EUCARPIA Ornamentals: Editing Novelty • Irrigation of Horticultural Crops • Postharvest Pathology • Growing Media, Composting, and Substrate Analysis • Vegetable Grafting • Precision Management of Orchards and Vineyards • Cucurbits

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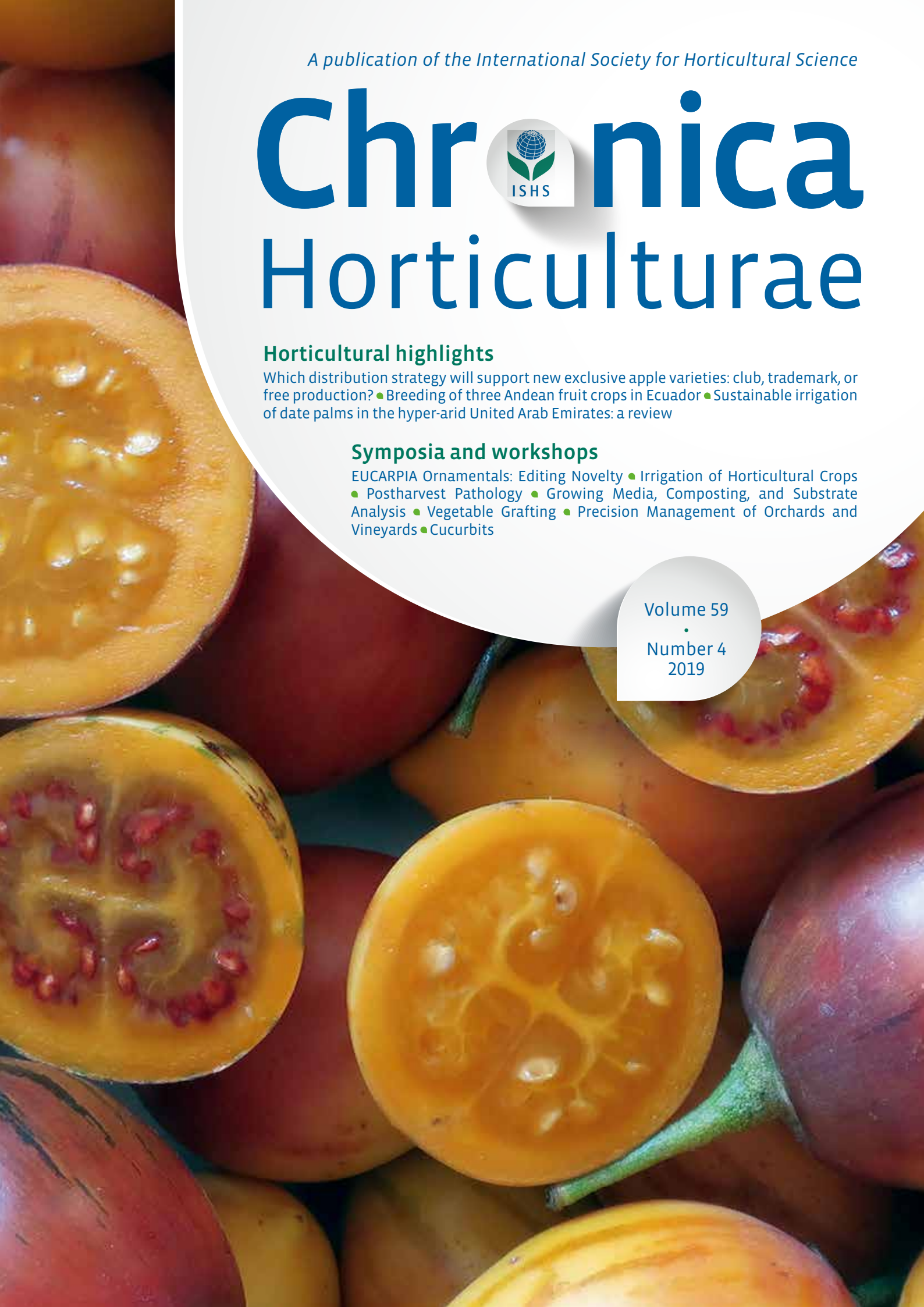

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Cover photograph: Tree tomato (tamamoro or tomate de árbol) fruit variability of interspecific crosses evaluated by the Fruit Program of the Instituto Nacional de Investigaciones Agropecuarias (INIAP), Ecuador. See article p.20.

› Sharing the wealth

Kim E. Hummer, ISHS Board Member, Treasurer

› Kim E. Hummer

Our Society has made great and positive changes in our operations over the past decade. We have implemented the Responsive Online System for *Acta Horticulturae* submission and review - ROSA (Drew, 2018) through the wonderful and great efforts and guidance of Professor Dr. Yves Desjardins, past ISHS Board Member for publications. Our present Board members, Professor Dr. Silvana Nicola and Dr. Jill Stanley, led the transformation of our 24 former scientific Sections and Commissions (Hummer, 2010) into the 14 sleek revised, efficient, and effective Divisions (Stanley, 2018). These Divisions manage similar numbers of Working Groups and symposia at much lower cost to the Society. Beginning in 2016, we initiated Symposia 2.0, where clusters of smaller symposia meet with continental or regional Congresses; once again a cost savings opportunity for the Society (Drew, 2018). At the last International Horticultural Congress in Istanbul, Turkey, the most diverse group of Board members ever for this Society were elected, ensuring broader and specific representation of members from Oceania, Africa, and Central and South America, in addition to those from Europe, Asia, and North America. Through another recent initiative, ISHS now places special emphasis on training and awarding our "young minds," which includes recently hired horticultural scientists, post-doctoral candidates, and graduate students (Paiva, 2019). Each *Chronica Horticulturae* now includes summaries written by award-winning "young minds" who presented their research at ISHS symposia. Also, international training workshops are being held for students such as the First ISHS Summer School on Pre- and Postharvest Physiology of Temperate Fruit Crops that occurred in Germany in 2018, and the ISHS School on Beverage Crops that will take place in Brazil in 2020 (Paiva, 2019).

We ISHS members are "waking up" to the call of the world. But more needs to happen for our Society to continue successfully into the future.

Our Society focuses on the science of horticulture. What I enjoy most about our Society is our symposia. These meetings mean that we are able to get together with colleagues from all over the world and discuss and debate the latest horticultural scientific findings in our study area. We convene in different unique and magnificent locations each time, take tours related to our subject, and write manuscripts summarizing a snapshot of the world of our science, which are published in our Society's very own *Acta Horticulturae*. This is what our Society does best and should continue to emphasize in the future.

Now that we have expanded with special emphasis on developing regions of the world, our meetings will take place in more remote sites and in more diverse countries as we reach out to more locations. In addition, we are recognizing new young scientific talent. In these cases, we who have managed successful symposia need to share our wealth of knowledge, not only in our subject matter expertise, but on how to organize, manage, and fund symposia. We need to share our skills of how to perform science, and how to write, edit, and publish manuscripts with scientists in the more remote parts of the world. Dr. Isaac Aiyelaagbe (2019), our African representative on the Board responsible for outreach and innovation, is encouraging us to broaden our horticultural reach to scientists in African communities. Dr. Patricia Duarte de Oliveira Paiva (2019), ISHS Board Member responsible for Young Minds, our South American representative, describes efforts to get "young minds" involved.

We need to provide additional training or guidance for developing countries and for our next generation in the "how tos" of managing symposia and publishing, besides education on the horticultural science subjects. We need to bring more conveners into the fold.

Perhaps the regional Congresses, such as the International Symposium on Horticulture in Europe, the All Africa Horticultural Congress or the Asian Horticultural Congress could provide workshops to train scientists from developing countries on how to host symposia as well as write and edit scientific papers in English. Perhaps non-governmental agencies, institutes, or foundations could sponsor scientists to attend such training.

In addition, the Society could arrange for workshops to be held in association with the national horticultural societies of the country, member states or regions. When conveners apply to host a symposium, we could suggest that they appoint a next generation advisor for their planning committee. This young mind could suggest how to communicate with the latest technologies and be a convener-in-training for a future event.

For our Society to meet with success, we must now recognize the needs and support a broader base of horticultural membership and constituents than has been present heretofore. The process of scientific publication is not an easy task to perform and many new scientists have not had resources to manage meetings.

Those of us with experience in managing symposia and preparing successful *Acta Horticulturae* could share our wealth of knowledge for a broader audience of horticulturists. I encourage experienced members of the Society to develop how-to presentations, videos, and educational aids for presentation at ISHS symposia, and suggest that seminars be developed to educate on the hard work of editing and preparing quality *Acta Horticulturae*.

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Spotlight on Honoured ISHS Members

› Ted M. DeJong

Position or previous position

Distinguished Professor of Fruit Tree Physiology, Pomologist in the California Agricultural Experiment Station and Cooperative Extension Specialist

ISHS honour

ISHS Fellow

› Ted's family picture in 2013. We are a UC Davis Aggie family. My three sons and their wives all graduated from UC Davis.

1. Tell us a bit about yourself (hometown, present location, family, hobbies, community involvement).

I was born and grew up in a small town in the central valley of California. Although my parents were not directly engaged in farming, my uncles were. I always had a strong affinity for farming. I worked on fruit and nut tree farms whenever I could during grade school and high school. I chose to go to a small liberal arts college (Calvin College in Grand Rapids, MI) because it was affiliated with my church denomination. Because that college had no agriculture courses, I chose the next best thing to major in: biology and ecology. After college I was faced with being drafted into the armed services so I volunteered to go into the US Army to opt for going to Officer Candidate School. After spending three years in the US Army, including ten months in Vietnam, I attended California State University, Fullerton, for an MS degree in Plant Ecology. Subsequently, I pursued a PhD in Plant Ecology working on the physiological ecology of beach and dune species at University of California, Davis. Ironically, although my interest in plant ecology stemmed from my early interest in farming, and UC Davis is renowned for its agriculture programs, I never took a single course in agriculture while studying there. After my PhD, I went to the Smithsonian Institution in Washington DC on a post-doctoral fellowship to study the physiological ecology of tidal marsh species. Subsequently, I returned to UC Davis for post-doctoral research on interactions between biological nitrogen fixation and photosynthesis in leguminous crops. As I have told my students many times, after my second post-doctoral study, I turned in my effort on peas to work on peaches. I then took a position in the Pomology Department at UC Davis.

I met my wife in college and we have been married for fifty-one years. We have three sons and ten grandchildren. Two of our sons are also University of California professors and one is a fire-fighter/paramedic. We spend a lot of our free time with family and are active members of our church. We like to travel and whenever possible we take the opportunity to explore countries associated with the ISHS symposia that I attend.

2. What got you started in a career in horticultural science?

My career in horticulture was not planned. I more or less fell into it when I took my position in the Pomology Department at UC Davis. I was hired to study and research the environmental physiology of tree crops. I never even gave a thought to being a horticulturist. After a year in the position my department chair encouraged me to consider attending a pre-congress pomology tour in northern Italy and the ISHS Horticultural Congress in Hamburg, Germany in 1982. After that experience I was hooked and have been an active ISHS member ever since.

3. Give a brief overview of your career/achievements.

Like many plant environmental physiologists, I began my career interested in the factors that control photosynthesis and the relationships between individual leaf photosynthesis and whole canopy photosynthesis. After several years of research I realized that tree canopies are amazingly adapted to optimize the use of light by distributing photosynthetic capacity of leaves within the canopy so that, under normal non-stressed conditions, canopy photosynthesis is often linearly related to canopy light interception. Furthermore, I came to the realization that after more than half a century of crop research there had been almost no success in improving crop photosynthesis over what plants are naturally adapted to do, other than through adjusting plant leaf angle. As a result, I became more interested in understanding how trees distribute and use their photosynthates and embarked on modelling fruit tree development, growth and carbon partitioning. This research resulted in the development of the first functional-structural, 3-D, virtual tree simulation models of the architectural growth of peach and almond trees. This modelling incorporated physiological processes such as photosynthesis, transpiration, photosynthate partitioning, carbon and water transport, and carbohydrate storage and mobilization over multiple years. In the process, we developed new paradigms for understanding fruit growth, responses of fruit growth to temperature during development as well as fruit thinning, the control of shoot development and growth, factors controlling shoot architecture, and a rationalization of factors controlling carbohydrate storage.

› Ted with fellow UC Davis pomologists (Carlos Crisosto, Harry Andris, Kevin Day and Scott Johnson) at his retirement event in 2016.

› Ted with peach researchers at the 2017 ISHS IX International Peach Symposium held in Bucharest, Romania.

I also have been intrigued with the physiology related to reduced growth caused by dwarfing rootstocks and, along with colleagues, have documented the involvement of reduced xylem cell size in causing reduced hydraulic conductance associated with size-controlling peach rootstocks. This phenomenon has been corroborated by other researchers working with several other species of tree crops. In conjunction with this research I have been involved in the release of six new rootstocks for peach.

Despite that I never took an academic course in horticulture, I became a primary instructor of pomology at UC Davis and particularly enjoyed teaching pomology courses that incorporated field exercises in fruit tree management as well as the fundamentals of tree growth, development and physiology. In recent years I have used my teaching and research experience to develop a two-week extension short course that has been taken by multiple international as well as Californian fruit and nut tree growers. I also taught graduate classes that emphasized the fundamentals of doing hypothesis-based scientific research.

In addition to my research and teaching, I have been involved in administrative activities, including Department Chair, and served on multiple academic committees. Most of these activities involved dealing with shrinking budgets. In these activities I did my best to maintain support for horticultural research and especially for maintaining access to facilities that provide opportunities for faculty and students to do effective field research.

4. What do you consider were your greatest achievements?

My greatest research achievements were related to the whole tree modelling effort and all the attendant projects related with that work. I was also involved in grower education and I am very satisfied with how I was able to use the modelling work to communicate an integrated understanding of how trees work so that growers can understand the physiology behind many common horticultural practices such as pruning and fruit thinning, as well as seasonal and annual responses to changes in weather.

I believe I was also successful at training numerous graduate students and young visiting scientists from numerous countries. I always made it an objective to try to help them develop experiments that resulted in at least one significant publication so that they would have something to show for their time in my laboratory. Several of these publications challenged “conventional paradigms” in pomology.

5. Did you encounter difficulties along your career path and how did you deal with them or how did you turn them into opportunities?

Although my original appointment was in the Pomology Department in Davis, I was assigned to work at the Kearney Agricultural Center located south of Fresno, CA, ~200 miles south of Davis. In addition, I was one of only five individuals in the UC system that had a split appointment in teaching (students at UC Davis), agricultural experiment station research and cooperative extension (extending information to the public). This appointment meant that I needed to assimilate traditional pomological dogma for the purpose of teaching students but also gave me the opportunity to test and challenge much of that dogma by seeing what was going on in the field and doing practical field research. This resulted in a new explanation for the double sigmoid curve of stone fruit growth, clearer knowledge of patterns and control of shoot growth, new understanding of the physiological basis for size-controlling rootstocks, rationalization of the process of carbohydrate distribution in trees, and a simplified approach to understanding annual carbohydrate storage and mobilization in fruit trees.

6. Tell us about one funny/exciting/interesting experience that happened to you during your career.

The first academic job interview that I went on was at a university in the Eastern United States. After the two-day interview process, I was on my way back to the airport when my host casually talked about the affirmative action pressures that their department was receiving and that their highest priority was to hire Asian professors. Then he looked at me and quickly said that of course that had nothing to do with the current recruitment and changed the subject. It was then that I realized how surprised they must have been to find out when I arrived for the interview that De Jong was not Asian but Dutch.

7. What made you become a member of ISHS and why did you keep the membership? What contribution or role has ISHS played in your career?

As I stated above, I became an ISHS member when attending my first ISHS Congress in 1982. It was at that congress that I realized that the ISHS provided access to a large network of researchers around the world doing research with pomological crops. Subsequently, I attended multiple individual ISHS symposia. I soon realized that the strength of ISHS is in these symposia, where researchers from around the world gather to discuss and share their research in groups that are small enough so that one can get to know almost everyone at the meeting, but large enough to have a diversity of approaches, topics and opinions presented. I have also greatly enjoyed associated travel to multiple countries where the crops that I work on are grown. These experiences have greatly enriched my professional and personal life.

8. What advice would you give to young people interested in a career in horticulture/horticultural science?

Join ISHS! While the research that is presented at ISHS meetings is often not at the highest scientific level available, it provides great access to seeing how scientific discoveries are practically applied to horticultural practices around the world. The opportunity to meet international researchers working on horticultural crops at ISHS meetings is unparalleled. A successful career in horticulture is not only about doing science. It also involves the application of science to practice. ISHS especially provides great opportunities for seeing and experiencing the latter.

9. What are the most interesting new roles or opportunities you see emerging in the future within horticultural science?

Over the past 30 years there has been a lot of excitement around the field of molecular biology and even publishing the genomes of horticultural crops. However, this has resulted in little actual, practical application in managing or improving horticultural tree crops. This is because most molecular biologists and many horticulturists only have rudimentary understanding of how tree crops work. This, along with technological advances in field data collection over temporal and spacial dimensions, provides a plethora of opportunities to ask new questions and explore plant behavior like never before. This can lead to development of greater integrated understanding of how plants work and to understanding how they can be manipulated to improve production and product quality in increasingly sustainable ways. When one really delves into the current state of knowledge in most horticultural topics, there are still many more questions than there are answers. In addition, the world is facing a crisis in adapting to changing climates and feeding future populations of people. Horticulture is more relevant than ever before.

› 2019 field trip of an annual Principles of Fruit and Nut Tree Growth, Cropping and Management short course offered by UC Davis.

› Ted with students of the 2018 ISHS FruitCRISP Summer School in Germany.

Which distribution strategy will support new exclusive apple varieties: club, trademark, or free production?

Silviero Sansavini and Roberto Gregori

One of the most important innovations in growing fruit trees is the bounty of newly introduced varieties that broaden the diversified fruit-qualitative platform each year. These varieties are either a result of genetic improvement programmes (cross-selection) or cloned natural mutations. Certainly, for European markets already saturated with trade and bolstered by the influx of apples from other continents, it is challenging for a new variety to spread and succeed (Bonany et al., 2014).

The aim of this article is to analyse the different ways new varieties are propagated and distributed. This task currently generates a very competitive business market for promoting and influencing consumer choice. The authors working in collaboration with several important European nursery companies, editors, and apple exclusivists, have summarized (Tables 1-3) the market trend achieved by the new exclusive varieties released during the last decade. The tables include fruit in Italy and other European countries with the formula of club, trademark, or free production and market.

The European regulation of "plant breeding rights" managed by CPVO (Angers), and the possibility to win market shares with the use of commercial brands has led editors and exclusivists to take the path of controlling the production-distribution chain of new varieties by using various contractual formulas generically known as "club." This type of chain control enables editors-managers to achieve certain objectives that can be summarised as follows:

1. Preparing a business plan for implementation over a fairly long – but not excessive – period of time, to recoup sufficient profit margins to cover the considerable investments required.
2. Choosing the most suitable geographical area in terms of environmentally suitable areas and qualitative enhancement of the apples; also identifying businesses/large producers and farmers' associations to be involved.
3. Planning the plantations on an annual basis and therefore the number of trees to be produced and planted each year, stipulating the relevant contracts both for the supply of trees (with the nurseries) and for growing, producing, and delivering the product (with the farmers' input).
4. Identifying trading groups and stipulating contracts to set quotas and manage the placement of apples on the market, or do this in-house if they have access to suitable companies and businesses and proven equipment and skills. In this case, therefore, the grower-producer as well as the nursery company becomes a simple product supplier who must comply with the regulations. The sale price is not preset but decided at the end of the season based on the market situation for apples in general, and for the released variety in particular.
5. Admitting excellent and distinct varieties through the club formula. This approach works only if the variety performs well in terms of quality, distinction of characteristics, continuity of trade flow, and above all, recognisability and thus specifically requested by the consumers. It is fundamentally important, therefore, that the management of the club achieves a "share-Premium market value for the apples" that would cover the costs of marketing, promotion, control over the supply chain, and compliance with regulations to pay growers as much as possible (no less than the grower would have earned in the absence of a contract) (Sansavini and Gregori, 2016).

The current tendency in the main apple-growing countries seems to favour the "club" system for introducing new varieties (Höller et al., 2017). Some experts predict that in the next few years the percentage of apple plantations accounted for by the club formula will grow from approximately 5% at present,

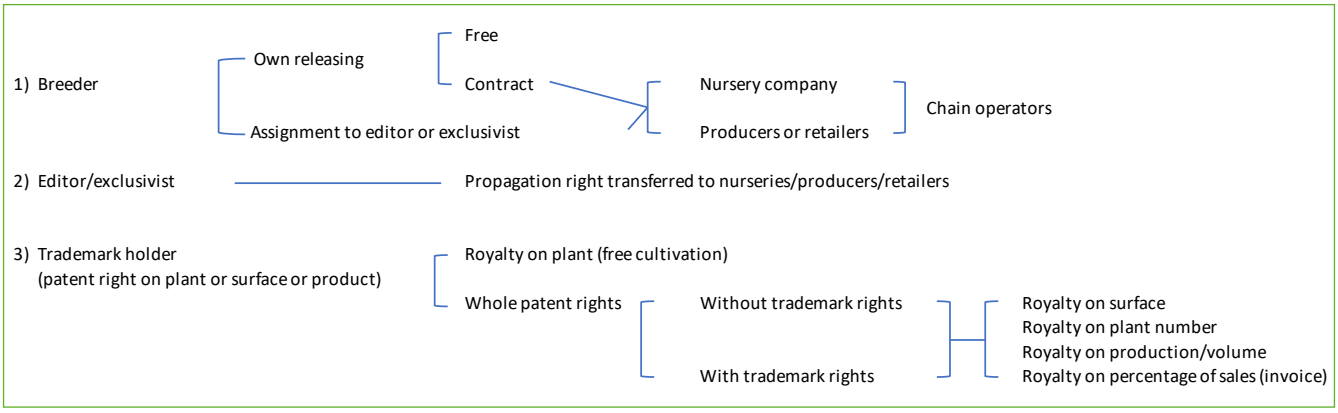

Figure 1. Layout of the distribution chain of the new varieties, depending on the propagation rights transferred to each operator from the producer to the marketer. Source: adapted from Sansavini and Lugli (2015).

■ Table 1. New exclusive apple varieties planted in Italy with "propagation and diffusion rights" loaded on production (Club) and on trees, in the last decade. Preliminary source: Guerra (2018b).

Variety	Trademark®	Country	Scab resistance	Harvest season	Growing area		
					South Tyrol	Other Alps areas	Northern lowland
Ambrosia		CA		Autumn	x	x	
Ariane[1]	Les Naturianes®	FR	x	Autumn			
Bonita		CZ	x	Autumn	x		
CIV323	Isaaq®	IT	x	Summer	x	x	x
CIVG198	Modì®	IT	x	Autumn	x		x
CIVM49		IT	x	Summer	x		
Civni	Rubens®	IT		Summer	x		
Cripps Pink/Rosy Glow/ Sekzie	Pink Lady®	AU		Winter	x	x	x
Cripps Red	Joya®	AU		Winter	x		
FEM 8		IT		Summer			
Fengapi	Tessa®	IT		Autumn	x	x	
Gradisca		FR		Autumn		x	
Ipador		BE	x	Winter	x		
Kizuri	Morgana®	BE		Autumn		x	
Lumaga	Galant®	CH	x	Summer		x	
MAIA1	EverCrisp™ (in progress)	US		Winter			
Majesty	(in progress)	IT		Winter			
MC38	Crimson Snow®	AU		Winter	x	x	x
Minneiska	SweeTango®	US		Summer	x	x	
Nicogreen[1]	Greenstar®	BE		Autumn			
Nicoter	Kanzi®	BE		Autumn	x		
PremA96	Rockit®	NZ		Autumn		x	
R201 (red skin)	Kissabel®	FR	x	Autumn	x	x	
Redlove (red skin series)		CH	x	Autumn			
Regalyou	Candine®	FR	x	Winter			x
RM1 e RS1 (red skin)	Red Moon®	FR		Autumn			x
RoHo3615	Evelina®	DE		Autumn	x	x	
Scifresh	Jazz®	NZ		Autumn	x		
Scilate	Envy®	NZ		Autumn	x		
Shinano Gold	yello®	JP		Autumn	x		
SQ159	Natyra® (organic), Magic Star® (standard)	NL	x	Autumn	x		
UEB32642	Opal®	CZ	x	Autumn		x	
UEB6581		CZ		Winter			
WA38	Cosmic Crisp®	US		Autumn	x		
WUR037[1]	Freya®	NL		Autumn			
Xeleven	Swing®	FR	x	Winter			x

[1]Not commercialized in Italy.

to around 15-20%. In Italy, for example, a recent survey at nursery and producer level (Guerra, 2016) highlighted thirty new club varieties which are subjected to farming regulation and supply chain control. For each of these, the areas involved are known, to predict production levels each year, and to implement suitable commercial strategies (see Table 1).

Only a few club editors-managers release statistical data that enable us to ascertain the real distribution of the variety and its average prices achieved by producers. The results have been positive for some. This is true, for example, for the policlonal 'Cripps Pink' variety and its mutants, 'Rosy Glow', 'Sekzie', all under the 'Pink Lady®' brand – the first historic brand established over twenty years ago – but only in relation to apples grown in the admitted countries, France, Italy, and Spain and now also Israel and Serbia. But other branded varieties have now become established in various European countries; these include 'Nicoter-Kanzi®', 'Ambrosia', 'CIV G198-Modì®', 'Roho 3615-Evelina®', 'Scifresh-Jazz®' and 'SQ159-Natyra®'. Very few of these apples are resistant to scab and other pathogens, e.g., 'Modì®' and 'Natyra®', which means that the market follows its own trends in terms of taste and appreciation, even though the drive towards products grown using organic methods should have favoured some of the new resistant apples (of which there are more than one hundred excellent quality types from European breeders) (Gregori et al., 2017; Sansavini and Tartarini, 2013).

Procedures and chain agreements to protect variety rights

But are we certain that the "club" approach will continue into the future? Could the latest trend of moving towards their simplification lead to desirable changes, such as a reduction in the management costs of the

› A-C. New Italian apple selections/varieties obtained in Italy (Laimburg and Bologna): A. LB4852 Russet apple selection from Research Center of Laimburg, Bozen, Italy (Guerra, 2018a); B. B48C251 Russet-brown apple selection from DiSTAL, University of Bologna, Italy (Gregori et al., 2017); C. B47G082 Pink-red, scab resistant apple selection from DiSTAL, University of Bologna, Italy. D-G. Some of the main apple club varieties of Europe: D. 'Swee Tango®', among the most interesting apples, originated by Minnesota University, USA; E. 'Regalyou-Candine®', very promising French apple, probably suited for lowland areas too; F. 'Kanzi®', the most successful new Belgian variety in Europe (Better3Fruit); G. 'Cripps Red-Joya®', mutant of 'Cripps Pink' ('Pink Lady®' brand). H. Field evaluation of new variety 'Ipador', another bicolor Belgian apple, at the 2nd year of planting (Laimburg, Bozen, Italy). I-J. New traits that new breeding proposes to the market: I. 'R201-Kissabel®' and 'Red Moon', two new red flesh apples still under evaluation; J. 'Fengapi-Tessa®', attractive and competitive apple vs. Gala Group with a later ripening. K-M. Mutations of 'Gala' (see Table 2): 'Devil Gala', 'Dark Baron®' and 'Gala Star®' – three clones of 'Gala' with dark red color, currently most requested by the market. N-P. Apple disease resistant varieties adapted for organic farming: N. 'Red Topaz', clone of the most widespread scab resistant apple in the world ('Topaz' from Czech Republic); O. 'Evelina®', the successful mutant of 'Pinova', the well-known German ecologic apple; P. 'Inored-Story®', the French (INRA-Novadi) most relevant scab resistant apple, free cultivated.

■ Table 2. Main variety clones, freely propagated with trademark name (royalties on plants).

Original variety	Mutation[1]	Trademark®
Braeburn	Mariri Red	Aporo®
Fuji	Aztec	Zhen®
Fuji	fenduf3	Fuji Phoenix®
Fuji	fenfu	Rubinfuji®
Fuji	Fubrax	Fuji Kiku®
Fuji	Fuciv181	Ko-Civ®
Fuji	Fuciv51	San-Civ®
Fuji	Fuji VW	King®
Fuji	Grofn Fuji	King®
Fuji	rofm811	Rubinfuji®
Gala	Alpi Gala	
Gala	Baigent	Brookfield®
Gala	Bigigalaprim	Early Red Gala®
Gala	CIVT51	T-Rex®
Gala	Devil Gala	
Gala	fensoon (in progress)	
Gala	fenstripe	
Gala	fenzem1	
Gala	Gala 2013	DarkBaron®
Gala	Gala Decarli Fendeca	
Gala	Gala Perathoner	Redlum®
Gala	Gala SchniCo	Gala Schniga®
Gala	Gala Schnico Red	Gala Schniga®
Gala	Gala Schnitzer	Gala Schniga®
Gala	Gala Simmons	Buckeye®
Gala	Gala Venus Fengal A	
Gala	Galafab	Gala Star®
Gala	Galaval	
Gala	kf576	Dark Ann®
Gala	RKD Gala	
Gala		Gala Magma®
Golden Delicious	Golden	Reinders®
Golden Delicious	Golden Parsi	da rosa®
Golden Delicious		Golden Smoothee®
Granny Smith	Dalivair	Challenger®
Jonagold	Red Jonaprince	Wilton's Star®
Jonagold	Red Jonaprince Select	Wilton's Star®
Red Delicious	CIVRD11	
Red Delicious	Erovan	Early Red One®
Red Delicious	Evasni	Scarlet Spur®
Red Delicious	Jeromine	
Red Delicious	King Red Delicious	Roat®
Red Delicious	Sandidge	Superchief®
Red Delicious	Stark Gugger	RedVelox®
Red Delicious	Valtod	Red Cap®
Topaz	Red Topaz	

[1]For the update list of the 'Gala' mutations, see Guerra et al. (2017).

clubs, or at least partially guarantee their recognised advantages as set out above?

The main criticism of the club system is that, until now, despite the incentives in its favour, it controls only 5% or perhaps even less, of overall apple production. Are we perhaps close to an optimal threshold that is difficult to overcome due to the operational mechanism of the club system itself? For example, what apple ideotype will be favoured and preferred by consumers when their purchases are more influenced by the choices of the large retail chains and other distribution channels, none of which are necessarily guided by commercial pressure from club managers? At the moment, the breeders are excluded. They cannot have a say in the variety drive and spread.

A similar criticism can be directed at editors-managers, who will try to push those apples onto the market for which they have made large promotional investments while acquiring the propagation rights, i.e., payments of royalties to the breeders in advance, with the result that these apples will not necessarily be of the truly premium, excellent quality that the clubs are supposed to have as an objective.

We would like to conclude this note with some reflections regarding the different strategies that some editors are now implementing to bypass the responsibilities and limitations of the club system, with the aim of continuing to safeguard the variety rights but with greater operational flexibility. We should bear in mind that breeding projects are no longer funded by governments in the main western countries. The public bodies that license the varieties – without private involvement – do not use club-based growing methods but restrict themselves to issuing patents to protect the rights of the variety breeders, and then freely launch their new varieties without constraints, e.g., USA, France, Italy. There are also private organisations that follow similar, less inclusive strategies, restricting themselves to protecting the variety denomination but controlling propagation in the nursery sector on an exclusive basis (number of trees and plantation locations).

In programmes managed by the public and private sectors together (now the majority), the private sector decides the means of dissemination in the end. Since the private sector has, for years, financially supported the implementation of the breeding programmes, it maintains the priority to choose the distribution strategy. An example of this is the American "Cosmic Crisp" apple, launched last year by Washington State University. Only the Grower Association, which for a long time supported the breeding programme, has the right to grow the variety.

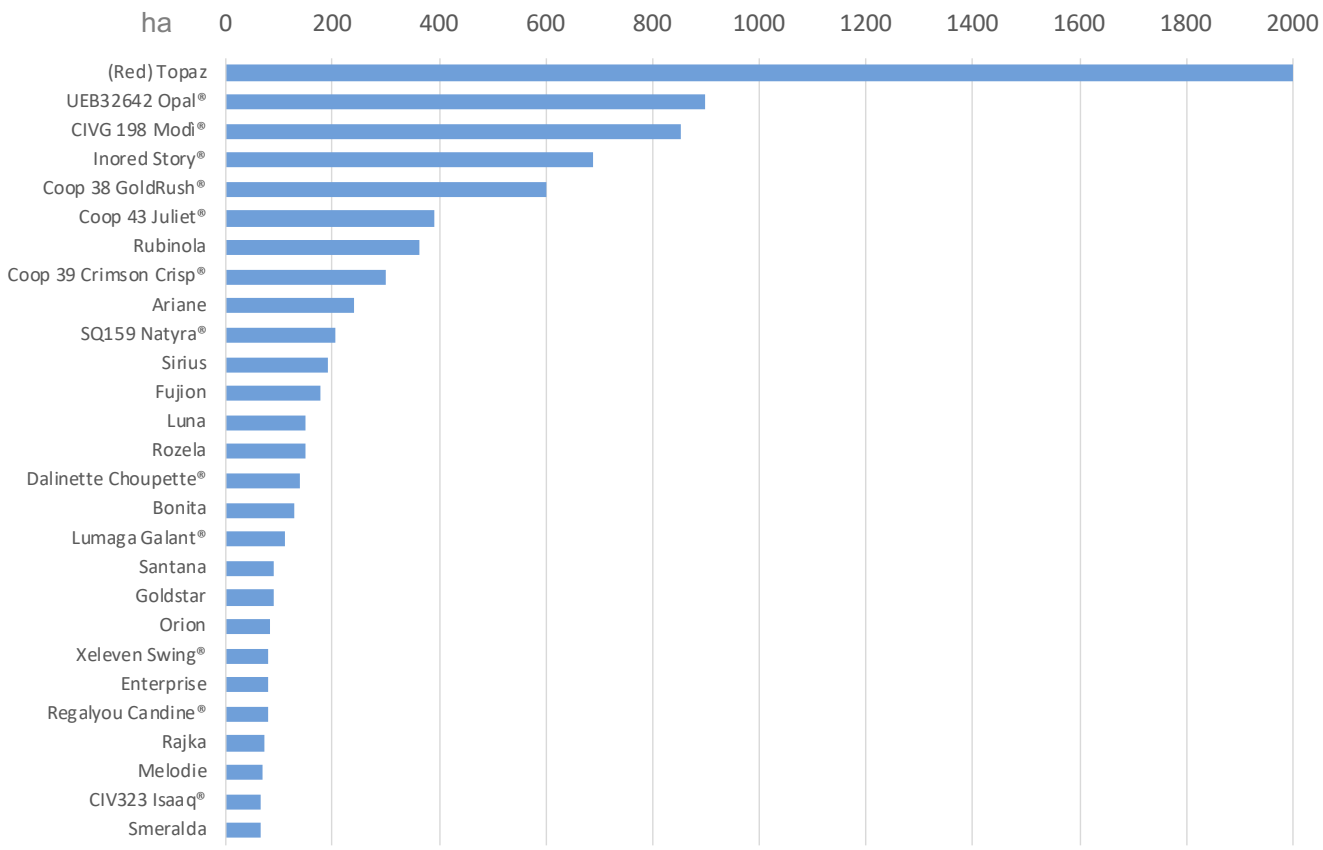

Figure 2. Scab resistant apple varieties planted on about 8500 ha throughout the world. Source: Guerra (2018a).

Only they could decide whether the variety can be grown in the member farms or in other areas or countries.

The innovative weapon that will decide future licensing systems is the "brand." The brand already overrides or subordinates not only breeders' rights, but also places the variety denomination. We already have some evident examples. More well-known brands in Italy, such as Melinda, Marlene, Melavì, Melapiù, Red Moon, Isaaq, and Kiku, include and aggregate together a number of varieties under only one apple denomination (umbrella-brand). They successfully retain consumer loyalty using only the name of the holding company that manages the brand, even bypassing any large retail private labels (superstores, discount stores). We know that some of these brands are managed justifying the agreement with the private organisations – including grower associations – that themselves financed the breeding programmes that created the varieties (or that bought "variety packages" from external breeders). This means that, in the future, these organisations will launch new varieties exclusively under their own brand. This path has already been followed for stone fruit and kiwifruit.

Now we are going through a period of transition that may lead to solutions that are all more or less coexistent and in some way dependent on the market. The hope, in any event, is that the search for simplification and management cost reduction will lead to improvements, and that the introduction of the best new apple varieties will bring greater benefits to producers and consumers.

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Table 3. Main varieties with and without trademark name, freely cultivated.

Variety	Trademark®	Editor and/or breeder	Scab resistance
Asfari		Better3fruit (BE)	
B3F44		Better3fruit (BE)	
B3F45		Better3fruit (BE)	
BAY 3484 (red skin)	Baya Marisa®	BayOZ (DE)	
Bellida		Wageningen Univ. (NL)	
Coop 33	Pixie®	PRI (US)	x
Coop 38	GoldRush®	PRI (US)	x
Coop 39	Crimson Crisp®	PRI (US)	x
Coop 42	Primiera®	PRI (US)	x
Dalinette		INRA & Dalival (FR)	x
Elise		Wageningen Univ. (NL)	
FN3505-354	Anise®	Pepinieres Escande (FR)	
Fresco	Wellant®	PRI (US)	
Fujion		CIV (IT)	x
Gaia		CIV (IT)	x
CH101[1]	Galiwa®	Agroscope (CH)	x
Gemini		CIV (IT)	x
Gold Pink	Gold Chief®	Bologna Univ. (IT)	
Golden Orange		CREA (IT)	
Imara		Better3fruit (BE)	
Inolov	Mandy®	INRA (FR)	x
Inored	Story®	INRA (FR)	x
Lespin	Garance®	INRA (FR)	x
Makali		Better3fruit (BE)	
Milwa	Junami®	Agroscope (CH)	
Pinova		Dresden-Pillnitz (DE)	x
Santana		Wageningen Univ. (NL)	x
Sinfonia		CIV (IT)	
Smeralda		CIV (IT)	x
Summercrisp		SVWO (DE)	x
Topaz		Inst. Exp. Botany (CZ)	x
Tramin		Feno srl (IT)	x
Zari		Better3fruit (BE)	
Zonga		Better3fruit (BE)	
X9585	Early Crunch®	Pepinieres Escande (FR)	

[1]Regulated by different contracts in Europe.

› Silviero Sansavini

› Roberto Gregori

› About the authors

Dr. Silviero Sansavini is Emeritus Professor at the University of Bologna, appointed full professor to the Chair, Arboriculture and Pomology, in 1971, and temporarily in charge of Fruit Science and Technology at the Free University of Bozen (1999-2006). He chaired the doctoral program committee in Fruit and Woody Tree Sciences and Landscape Planning at Bologna University (1984-2008) and was co-founder of the International Doctoral School for Genomic and Molecular Physiology of Fruit at San Michele all'Adige, Trento (2009-2014). He is the recipient of Honoris Causa degrees from the Horticultural Science University of Budapest (1981), the Academy of Agriculture together with the University of Bucharest (2011) and Polytechnic (University) of Lisbon (2013). He is a past-president of the International Society for Horticultural Science (1994-1998) and a former chair of its Fruit Section (1986-1994). He headed the Italian-Swiss team that engineered apple variety 'Gala' with scab resistance, adding *Vf* gene (2004). He was the convener and organizer of the joint American Society for Horticultural Science and ISHS "World Conference on Horticultural Research" (Rome, 1998). He received awards from the ASHS (1995), the American Pomology Society (2000), the Royal Horticultural Society (2001) and ISHS (2002). He was co-founder of EUFRIN, the European network for research collaboration. He is scientific editor of the Italian monthly *Rivista di Frutticoltura*. The main book edited by S. Sansavini with several co-authors is "Arboricoltura generale" (in Italian), and the English revised and updated version "Principle of Modern Fruit Science" was published by ISHS in 2019. E-mail: silviero.sansavini@unibo.it

In 1998, Dr. Roberto Gregori began at Bologna University with a fellowship on postharvest storage and diseases of fruits and vegetables at the Department of Agri-food Protection, Criof Research Center. He graduated from the Faculty of Agriculture in 2001, and obtained his PhD in Plant Pathology from the University of Bologna in 2006. He then spent six months at the Department of Plant Sciences, University of California, Davis, where he improved his scientific skills. In 2009, he started work at the Department of Coltivazioni Arboree (Fruit and Woody Plant Science), University of Bologna. He is currently involved in coordinating several field trials of the Experimental Center under the agronomic aspects, plant protection and variety choices. During the last few years, he collaborated with Professor S. Sansavini as co-coordinator of the Working Group for the Ministry of Agriculture on "apple and pear variety assessment". Now, he is working on the breeding and selection of apples. Several of these varieties are almost ready to be patented. He has published more than eighty papers in national and international technical and scientific journals. He has participated in conferences as a speaker and contributed to university teaching as a laboratory and field instructor. In addition, he has been involved in safety procedures and the evaluation of quality standards for fruit tree cultivation guidelines for integrated and organic cultivation. E-mail: roberto.gregori4@unibo.it

Horticultural Science News

› ISHS Young Minds Award winner summaries

Below is a selection of research summaries from winners of ISHS Young Minds Awards for best oral and poster presentations at ISHS symposia. To view other exciting research summaries by other winners, please visit www.ishs.org/young-minds-award.

Light interception and yield of sweet cherry and apricot trees grown as a planar cordon orchard system design

› Claire Scofield

Claire Scofield is currently pursuing a Master of Science at Massey University, Palmerston North, while working as a Research Associate at The New Zealand Institute for Plant and Food Research Limited, Clyde Research Centre, New Zealand. Her work has a strong focus on pre-harvest and postharvest physiology of stone fruit, particularly cherry and apricot. Her research entitled "Light interception and yield of sweet cherry and apricot trees grown as a planar cordon orchard system design" was presented at the IHC2018 in Istanbul, Turkey. Her objective was to quantify light interception properties within a planar canopy system for both cherry and apricot. An additional objective was to understand how and why these properties differ from those of a conventional centre leader planting system of the same age.

Previous studies on apricot have shown a strong correlation between fruit quality and light conditions within the canopy. Thus, this study made an initial determination of the orchard light interception and variations across the row alley before more in-depth investigation into the light-fruit relationships within a planar canopy. While proportional whole canopy light interception (% photosynthetically active radiation) for mature conventionally grown apricot and cherry canopies showed high interception up to 85%, as little as 2% of the light reached the lower inner portion of the trees. With almost 100% of the incoming light being intercepted at the trunk, an analysis of the light distribution across the row alley was investigated to understand the total light intercepted within the orchard system.

In cherry, the average light interception in a 5-year-old planar cordon canopy varied between 63.6 and 71.9% depending on the row spacing. In a centre leader system of the same age, the average light interception was only 43.6%. When analysing the overall system by assessing the row alley light distribution pattern, the planar cordon system had as little as 15% difference between the centre of the tree and the mid alley compared with a difference of 23% in the centre leader system. The light distribution beneath planar cordon canopies was more uniform than with the centre leader orchard system, where few differences were seen between under-tree and within row alley, suggesting that the growth structure of a planar canopy was more even in comparison to a centre leader canopy. This work was a preliminary inquiry to measure the light environment in young planar systems. Future work aims to determine relationships between light distribution and fruit quality (and its variability) in cherry and apricot.

Claire Scofield won an ISHS Young Minds Award for the best oral presentation at the International Symposium on Evaluation of Cultivars, Rootstocks and Management Systems for Sustainable Production of Deciduous Fruit Crops at IHC2018 in Turkey in August 2018.

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Parameter estimation for respiration rate of dragon fruit as a function of gas composition and temperature

› Phuc Le Ho

Controlled atmosphere or modified atmosphere packaging are clean and potentially effective techniques to extend the storage life of dragon fruit (*Hylocereus undatus*). Application of these techniques requires thorough knowledge about the fruit respiration rate. To this end, this study aims to model the respiration rate as a function of O_2 and CO_2 level, and temperature, using Michaelis-Menten kinetics and Arrhenius' law.

Dragon fruit were incubated in closed containers with different initial O_2 concentrations (5-21%), initial CO_2 concentrations (0-10%), and temperatures (2-35°C). A mathematical model based on Michaelis-Mentel kinetics, Arrhenius' law, and Boltzmann distribution function was used to describe respiration rate as a function of temperature, O_2, and CO_2 concentration. Data on gas concentration was used to estimate the model parameters, based on the least square principle.

The combined Arrhenius-Boltzmann equation was able to describe the reduced increase in respiration rate at high temperature. The estimated model could describe the dragon fruit respiration rate accounting for 98% of the data variance. The estimated parameter showed that CO_2 had an uncompetitive inhibition on the respiration. O_2 concentration significantly affected both respiration and fermentation. These results will be useful for further studies on the application of controlled or modified atmosphere on dragon fruit quality.

Phuc Le Ho won an ISHS Young Minds Award for the best oral presentation at the VI International Symposium on Applications of Modelling as an Innovative Technology in the Horticultural Supply Chain - Model-IT 2019 in Italy in June 2019.

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Performance evaluation of a non-chemical weed control machine for vineyards and orchards operating with high pressure cold water

› Massimiliano Varani

During the last several decades, environmental pollution problems caused by the extensive use of chemical herbicides have encouraged the introduction of integrated crop production. A further boost to these methods has been provided by market demand, where organic or "biologique" products are increasingly requested by consumers. In vineyards and orchards, one of the most widely used methods of non-chemical weed control is through the mechanical action of agricultural implements. Commonly, these implements are characterized by rotating blades operating inter-row, but this typology of machines could damage plant roots and it is subjected to failures in stony soils. To overcome these problems, some manufacturers have developed flame or steam weeders, but the limited operating speed leads to an increment of management costs. An innovative solution was designed by Caffini® Sprayer Equipment (Italy) with the implement called the "Grass Killer" that controls weeds with high-pressure cold water. The high-pressure water stream (around 1000 bar) is obtained with a piston pump connected to the power take off (PTO) of the tractor and it is applied on weeds through a rotating inter row disc with nozzles. The objective of this study was to evaluate the performances of this machine in terms of weed control efficiency and energy consumption. Tests were performed in an orchard connecting the "Grass Killer" to a New HollandTM T4.110LP (CNH Industrial Italia SpA Company, Turin, Italy) equipped with a controlled area network logger and a global positioning system (GPS). To measure the energy required by the piston pump of the implement, a torque-meter was installed on the PTO of the tractor. To compare the weed control efficiency of the Grass Killer, one side of the orchard rows was treated with a traditional grass mulcher operating inter row. On the day of the test, normalized difference vegetation index (NDVI) images were taken with a custom-built quadrotor flying drone before the two implements performed the weed control operation. Subsequently, 15 days later other NDVI images were shot to observe weed regrowth. The results show that the power required by the piston pump of the implement is about 27 kW, which is roughly 60% of the total power needed by the tractor to run the operation. In addition, NDVI images show that weed regrowth was much slower in the sides of the orchard rows tilled with the Grass Killer.

Massimiliano Varani won an ISHS Young Minds Award for the best poster at the VI International Symposium on Applications of Modelling as an Innovative Technology in the Horticultural Supply Chain (Model-IT 2019) in Italy in June 2019.

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Deficit irrigation strategies on yield components and quality of *Vitis vinifera* L. 'Touriga Franca' under Mediterranean climate

› Inês Cabral

I graduated with a B.S. in Biology from the Faculdade de Ciências da Universidade do Porto (FCUP), Porto, Portugal, in 2012. I then obtained an M.S. in Biological Aquatic Resources. In 2015, I began an M.S. in Agricultural Engineering studying irrigation in vineyards at the same institution. I am a member of "GreenUPorto – Sustainable Agrifood Production" Research Centre and am currently a PhD student. My goal is to understand how irrigation affects fruit and wine production in the Douro Region, one of the oldest production regions of the world. In this region, irrigation was considered a detrimental factor until recently. Grape production of wine is one of the most important agricultural products with a total of 6,557,592 hL produced in 2017. This region is predicted to be one of the most affected by climate change. With decreasing precipitation, rising temperature, and increasingly frequent extreme events, the study of irrigation is becoming critically important for grape production. The application of different quantities of water in two different periods is being studied in two field-grown native cultivars widely used in the region, 'Touriga Franca' and 'Touriga Nacional'. Production under irrigation is being compared to the common practice of non-irrigation. This work aims to understand how applied water will affect both platform field determinations, including leaf water status, total leaf area, pruning weight, canopy density, number of clusters, and weight of clusters per plant. Berry analysis at harvest will also be performed to compare quality parameters like probable alcohol, anthocyanins, polyphenols content, pH, total acidity, and malic acid content in the different irrigation treatments. The trial started in 2015 and the results have been encouraging even despite inter-annual climate variability. Some results are promising, with an improvement in the fruit quality and yield.

Inês Cabral won an ISHS Young Minds Award for the best oral presentation at the IX International Symposium on Irrigation of Horticultural Crops in Italy in June 2019.

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Canopy conductance of hazelnut orchards appeared insensitive to irrigation regimes

› Gaia Pasqualotto

The hazelnut (*Corylus avellana* L., 'Tonda Gentile delle Langhe' (TGL)) remains one of the most appreciated nut trees by the food industry. Its production has been expanded world-wide to allow extensive plantations. Still TGL is known to be highly sensitive to climate outside of Piemonte, Italy. Its moisture sensitivity is expressed as a rigid stomata behavior with stomata closing in the early morning at a vapor pressure deficit of the atmosphere (VPD) of 10 hPa. We hypothesized that because of its sensitivity to VPD, TGL would have a limited benefit from increasing the irrigation regime because of the small impact in the total canopy conductance and on carbon assimilation and yield. We monitored six TGL hazelnut trees during two growing seasons in San Sebastian, Chile. We measured climatic parameters, sap flow, and soil water content in two irrigation treatments, T100 (standard irrigation) and T200 (doubled irrigation). Our result showed that the response of sap flow to VPD remained consistent in the two treatments. The sap flow density in T200 was significantly higher than T100, but the diurnal canopy conductance was ›17% in T200 respect to T100 only in a restricted interval of VPD, i.e., 4-12 hPa around a peak of 7 hPa. Our results suggested that doubled irrigation caused an increase in canopy conductance only in few climatic circumstances. These results suggest that benefits from increased irrigation occur only at low VPD. In such conditions, stomata are more prone to gas exchanges and carbon sequestration, a proxy for crop yield.

Gaia Pasqualotto won an ISHS Young Minds Award for the best poster at the IX International Symposium on Irrigation of Horticultural Crops in Italy in June 2019.

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Grafting watermelon to interspecific hybrid rootstock reduces hollow heart disorder

› Marlee A. Trandel

Marlee A. Trandel is a PhD candidate in the Department of Horticultural Sciences from North Carolina State University, USA. She completed her BS in Animal Science from the College of Agricultural Sciences, a BA in Chemistry from the College of Biochemistry and Chemistry in 2014, and her MS in Horticulture Sciences in the College of Agricultural Sciences in 2016 from Southern Illinois University Carbondale. She is currently studying for her PhD in postharvest physiology under the guidance of Prof. Dr. Penelope Perkins-Veazie. Ms. Trandel has completed her grafting watermelon field research and is currently focusing on finishing up laboratory work and writing her thesis.

In the U.S., seedless (triploid) watermelon cultivars make up 95% of the market. A disorder found mostly in seedless watermelon genotypes is hollow heart (HH), which causes an internal split or void in the placental tissue. Currently the cause of HH is undetermined, but researchers have suggested multiple factors induce the disorder, such as watermelon genetics, pollination/pollen viability, flower bloom time, decreased fruit tissue firmness and environmental stressors.

Grafting watermelon onto squash rootstocks (RS) has provided a means of combating soil borne diseases/nematodes and for changing the fruit quality attributes of tissue firmness, rind thickness and phytonutrient qualities. Grafting onto interspecific hybrid RS increases tissue firmness in harvested fruit and may decrease the susceptibility of HH formation in triploid watermelon. Fruit with larger cells generally have lower tissue firmness and tissue density is related to the number of fruit cells in the heart tissue and the subsequent cell size.

Marlee's research follows grafting and its effect on fruit tissue firmness and incidence of hollow heart. She used a susceptible triploid watermelon cultivar, 'Liberty', grafted onto interspecific hybrid RS (*Cucurbita maxima* × *C. moshata*) 'Carnivor' and 'Kazako', bottlegourd rootstock (*Laginaria sciaria*) 'Emphasis' and non-graft (control). Diploid pollenizers were limited by planting 6, 9 and 12 m apart in row (tier 1, 2 and 3). Fruit were harvested 64 to 78 days after transplanting. Fruit were taken to the lab and fruit weight and length × width (cm) were determined. Fruit were cut longitudinally and assessed for the incidence and severity (1 to 5 scale, 1 = no or minor and 5 = severe) of HH. Rind and heart firmness (N), pH, soluble solids, lycopene, arginine and citrulline were measured. Subsamples were analyzed with a Zeiss LSM 880 Confocal workstation for cell number and cell size (μm^2).

Distance from the pollinizer (6, 9 or 12 m) did not affect the incidence or severity of HH and data were pooled to determine RS effects. The total percentage of fruit with HH differed with RS. Fruit from 'Carnivor' and 'Kazako' had the lowest incidence of HH, with 32 and 38%, respectively. Fruit weight and volume were lowest for 'Carnivor' compared to other RS. Fruit volume was significantly increased in all watermelons with HH compared to no HH fruit (7.53 and 6.96 L), respectively. Heart tissue firmness was lower in fruit with HH compared to those without HH, averaging 16 and 18 N, respectively. Heart tissue firmness in watermelons without HH was highest in fruit from interspecific squash hybrids 'Carnivor' and 'Kazako' compared to non-graft or 'Emphasis' RS. Soluble solids content was lowest in fruit from 'Carnivor' fruit and was slightly reduced in fruit with HH. No differences were seen in compositional assays (e.g., phytonutrients). Cell number did not differ significantly among RS or with level of HH within RS. Cell number was lowest in fruit from 'Carnivor' with moderate to severe HH and in non-graft fruit with moderate HH, and was highest in fruit from 'Emphasis' with severe HH. Cell size was largest in fruit from 'Emphasis' (mean of 108.2×10^3 μm^2). Fruit with severe HH from 'Carnivor' and non-graft RS had larger cell areas, yet cell area was smaller in fruit from 'Emphasis'. Cell number was inversely correlated to cell size (R^2 = -0.8598, $p<0.001$). Marlee is currently exploring the cell wall architecture, specifically pectin type and amount, in graft and non-grafted fruit and the incidence of HH.

Ms. Marlee A. Trandel won an ISHS Young Minds Award for the best oral presentation at the II International Symposium on Vegetable Grafting in USA in July 2019.

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Perceptions of climate change and adaptation strategies implemented by the winegrowers of the Méntrida Denomination Region

› Chloé Plumas

This study focuses on the processes of developing climate change adaptation strategies by grape growers producing wine. This is part of a geographical approach that considers grape vine cultivation practices, the environment, and the effect on humans. The hypothesis tests the perception that climate change and the representations by stakeholders play an important role in the adaptation process and in the agricultural practices. Secondly, chosen agricultural practices strongly influence landscape changes, such as intensive viticulture versus traditional viticulture with different levels of mechanization. As of 2019, Spain is the leading wine exporting country. It joined the European Union in 1986. Spanish growers were concerned by premiums that were proposed to limit wine production surpluses on a community scale. This led to planting new cultivars which have turned out to be very productive. At the same time, the introduction of new viticultural and oenological practices has contributed to an overall improvement in wine quality. However, considering climate change, these practices may not continue to be sustainable. In February 2019, in the DO Méntrida Region of Castilla-La Mancha in Toledo, Spain, a special field survey was conducted to investigate this hypothesis. The first results show that different postures adopted by winegrowers regarding climate change, lead to changes in agricultural practices. However, the awareness and understanding of climate change remains very low. Some practices are counter to sustainable adaptation, despite the establishment of local awareness and information structures.

Chloé Plumas won an ISHS Young Minds Award for the best poster at the Chenin Blanc International Congress in France in July 2019.

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Soil physico-chemical properties on the distribution of *Rhododendron* species in China

› Shusheng Wang

Shusheng Wang graduated from Huazhong Agriculture University, Faculty of Life Science and Technology, in 2007. Since then, he has been working at the Lushan Botanical Garden, Chinese Academy of Sciences, on the conservation of wild *Rhododendron* species and breeding for new cultivars. He has been studying for his PhD since 2016 at the Flanders Research Institute for Agriculture, Fisheries and Food (ILVO) cooperating with Ghent University.

Rhododendron is one of the most important ornamental plant genera encompassing nearly 1000 species. The majority of *Rhododendron* species occur in China. Rhododendrons are typically calcifuges that cannot grow well in lime soils. Shusheng Wang's PhD research focused on screening and physiological characterization of lime tolerance in *Rhododendron*. As an important part of the PhD research, he investigated the effects of soil physico-chemical properties on the distribution of *Rhododendron* species in China, based on herbarium specimen and geochemical data. The herbarium specimen data were retrieved from the Chinese Virtual Herbarium. For more than 30,000 specimens, detailed information on location was present, which allowed geocoding into GPS data. Data on soil properties were present in the Harmonized World Soil Database (HWSD). Finally, the GPS data were linked to the distribution of 31,146 specimens and 525 taxa of *Rhododendron* to 60 soil units defined in the HSWD. Soil physical properties, such as gravel content, sand/silt/clay fraction, bulk density, and chemical properties like organic carbon content, pH, cation exchange capacity, base saturation, total exchangeable bases, calcium carbonate, sodicity and salinity in each soil unit and their correlation with the number of specimens and species were analysed. The results indicated that Haplic Luvisol (LVh) is the dominant soil unit for the distribution of *Rhododendron* species. Six soil units with more than 2000 specimens were Haplic Luvisols, Chromic Cambisols, Haplic Acrisols, Haplic Alisols, Cumulic Anthrosols, and Humic Acrisols with 9878, 2931, 2917, 2791, 2719 and 2019 specimens, respectively. The results showed that pH is one of the main properties that affect the distribution of *Rhododendron* species. The distribution maps of six soil units with the most specimens in China were generated. These data provide information that is useful for *Rhododendron* breeding programs and enable the identification of interesting species adapted to specific soil physico-chemical properties.

Shusheng Wang won an ISHS Young Minds Award for the best oral presentation at the XXVI International Eucarpia Symposium Section Ornamentals: Editing Novelty in Germany in September 2019.

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Physiological and genomic tools to improve postharvest quality of zucchini

› Raquel Jiménez Muñoz

Raquel Jiménez Muñoz is a PhD student at the Department of Plant Physiology at University of Granada, Spain. She completed her B.S. in Biology from University of Granada in 2014, and attained her M.S. in Advances in Agricultural Biology and Aquaculture from the same university in 2015. During her Master studies, she worked in pest control in the olive grove. Later, she was awarded a PhD grant from the Spanish Ministry of Economy and Competitiveness to pursue her doctorate. She is currently studying in the group AGR209: "Postharvest physiology in fruits of agronomic interest", led by Prof. Dra. Dolores Garrido. Her research project is focused on postharvest of *Cucurbita pepo* L. and is entitled "Development of physiological and genomic tools to improve postharvest quality of the fruit of zucchini". The subtropical origin of zucchini makes the fruit very susceptible to developing "chilling injuries" (CI) when kept at low temperature during postharvest. These CI are metabolic and physiological alterations that cause huge economic losses. The project is divided into two areas: one consists of different treatments that could improve the postharvest quality of the fruit, and the other is the development of transformation techniques for the study of cold resistance candidate genes. In a previous project developed by this research group, a transcriptomic comparison of different zucchini cultivars with contrasting behavior against cold stress allowed the identification of several candidate genes that appear to be important for chilling resistance. Raquel is working on the implementation of an *Agrobacterium*-mediated transformation and regeneration protocol to elucidate the role of these genes during cold stress.

Raquel Jiménez Muñoz won an ISHS Young Minds Award for the best poster at the VI International Symposium on Cucurbits in Belgium in July 2019.

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Multiparental QTL analysis: can we do it in polyploids?

› Alejandro Thérèse Navarro

Alejandro Thérèse Navarro is a first-year PhD student in the Laboratory of Plant Breeding at Wageningen University & Research, The Netherlands, working on his thesis titled "Molecular breeding and evolution in allopolyploids: novel and applied methodologies." He focuses on statistical tool development for the analysis of polyploid crops. His main interest is computational analysis of plant breeding data in order to understand the biological characteristics of crops. To that end, he has been studying polyploid genetic mapping. He obtained his MSc on Plant Biotechnology at the same laboratory with his thesis research: "QTL mapping in Multiparental Polyploid Populations: Development of Computational Methods in R". During his PhD he continues to work on this topic.

Polyploid quantitative trait locus (QTL) analysis tools have been developed in recent years and remain limited in the population types they can accept. They tend to focus either on biparental crosses or diversity panels for genome-wide association studies (GWAS). The former is a limited tool due to the restricted genetic diversity of the cross, while with the latter, weak or rare alleles cannot be estimated. Multiparental populations (MPPs) are an alternative where a few parents are crossed to obtain connected biparental populations. In plant breeding efforts, such schemes are common, and thus developing QTL analysis for MPPs increases the usefulness of these *ad hoc* MPPs. In this study, we simulated tetraploid MPPs and developed a QTL modelling approach to find the simulated QTLs. This allowed us to identify the main factors influencing QTL analysis in polyploid MPPs. We present the QTL modelling approach that best suits polyploid MPPs, based on identity-by-descent (IBD) QTL models presented in previous literature. These models require identification of the number of alleles segregating in the population. For that purpose, haplotyping, the concatenation of multiple SNP alleles, can be used. Thus, biallelic SNPs can be transformed into multiallelic markers, to better estimate the QTL effects. However, polyploid haplotyping is a complex problem, and although it has received attention recently, no methods have been developed yet for polyploid MPPs. Additionally, modelling approaches for MPPs must accommodate genetic structure, the non-homogeneous distribution of genetic similarity across the population. Such models include mixed models (such as the "unified mixed model") and Bayesian models (such as those implemented for diploids in FlexQTL).

To conclude, our results showed that the correlation between genetic structure and phenotype variation decreases QTL detection power in MPPs. That is to say, if all genetically similar parents contribute similar genetic effects, QTL peaks cannot be detected. Moreover, our results seem to indicate that the haplotype-based approach is only slightly more sensitive and accurate than the SNP-based approach. As the haplotype-based approach is computationally more demanding, SNP-based QTL analysis for QTL detection is recommended, followed by haplotype-based refinement.

Alejandro Thérèse Navarro won an ISHS Young Minds Award for the best oral presentation at the XXVI International Eucarpia Symposium Section Ornamentals: Editing Novelty in Germany in September 2019.

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The world of Horticulture

Breeding of three Andean fruit crops in Ecuador

William Viera, Andrea Sotomayor and Pablo Viteri

Introduction

Neotropical countries such as Ecuador include many centers of species diversity. The Andean fruit crops such as the naranjilla (*Solanum quitoense* Lam. and hybrids), tree tomato (*Solanum betaceum* Cav.), and the blackberry (*Rubus* L.) are of primary interest. These crops have high potential for the local and international markets (Viteri, 1999). The objective of this manuscript is to summarize breeding and germplasm activity for these three crops in Ecuador.

To improve its competitive fruit production, Ecuador must diversify its horticultural production. Development of local Andean fruit crops would be a good and healthy addition for global food consumption. During the green revolution, production of traditional local crops decreased, while non-traditional staple crop monoculture was emphasized (IICA - PROCIANDINO, 1997). Now that more is known about the nutrition of native species, the so-called "healthy foods," including Andean fruits, are of great potential interest for production and marketing due to their nutraceutical characteristics (Araya and Luts, 2003).

According to Lobo (2006), Andean fruit crops include species with diverse developmental production potential. The cultivation in their initial stages is performed with heterogeneous materials selected by farmers using low technology. Governmental and non-governmental organizations have initiated germplasm collections or genebanks of crop wild relatives to preserve, characterize, and evaluate the attributes of these fruits (Zhou et al., 2002). In addition, these wild species collections are a future source of genes for breeding cultivars with increased fruit productivity and quality (Cui et al., 2001).

Figure 2. Naranjilla fruits.

In the short term, breeding materials are based on mass selection, with a participatory approach, and to clone elite individuals (Gepts and Papa, 2002). In the medium and long term, breeding focuses on the creation of a broad genetic base through the formation of populations by crossing wild relatives with cultivated species (Lobo, 2006).

In Ecuador, genebanks of several Andean fruit crops have been established. Fruits have been characterized based on adaptation, yield, pest resistance, and fruit quality. The Fruit Program of the National Institute of Agricultural Research (INIAP) has focused on genetic breeding in tree tomato, naranjilla, and blackberry. The program objectives are to increase productivity, resistance to pests and diseases, and improve quality for fresh fruit consumption or industrial use. The goal is to improve the competitive and commercial potential of Ecuadorean crops within a sustainable management system.

Figure 1. Naranjilla plant.

Naranjilla (*Solanum* hybrids)

Crop characteristics

Naranjilla or lulo (*Solanum* L.) (Figure 1) is an Andean fruit crop of the *Solanaceae*. This fruit is in the *Lasiocarpa* section of the *Leptostemomum* clade, which includes about 13 tropical species (Heiser, 1993; Heiser and Anderson, 1999; Bohs, 2004). Two botanical species have been recognized: *S. quitoense* without thorns on stems and leaves, which is cultivated in Ecuador (Soria, 1997), and *S. septentrionale,* with thorns, which is grown in Panama, Costa Rica, and the central part of Colombia (Heiser, 1972).

The center of species diversity includes Colombia, Ecuador, and Peru (Heiser and Anderson, 1999; Lobo et al., 1983; Lobo and Medina, 2000). This fruit crop grows mainly in the humid subtropical forests of the foothills of the Andes Mountains (Heiser, 1985). In the producing countries, the cultivation has extended to areas with temperatures between 16 and 24°C and rainfall above 1500 mm, at altitudes between 800 and 1800 m (Revelo and Sandoval, 2003; Revelo et al., 2010).

Naranjilla is a shrub that can reach 2 m in height, has a pubescent, vigorous and branched stem with large oval oblong leaves, green in color and with prominent violet ribs.

Figure 3. Plant attacked by *Fusarium oxysporum*.

Figure 4. Fruit of naranjilla with anthracnose symptoms.

Flowers are hermaphroditic and are grouped in corymbs of 3-12 inflorescences that have velvety chalice of violet color and corolla of white petals. Fruits are spherical or slightly flattened, covered with a soft and dense hairiness, with an intense yellow-orange skin, greenish or yellowish pulp, bittersweet flavor and numerous seeds (Figure 2) (Heiser, 1985; Bohs, 2004; Revelo et al., 2010). These characteristics suggest that this species could be improved through domestication (Lobo et al., 2007).

According to the Ministerio de Agricultura, Ganadería, Acuacultura y Pesca (MAGAP, 2009), about 5025 ha of naranjilla are cultivated in Ecuador. This area produces 22,596 t of fruit with an average yield of 4.5 t ha^{-1}. Naranjilla is grown mainly in the Amazon Region, in the Napo, Pastaza and Morona Santiago Provinces, and in a smaller scale in Sucumbíos, Zamora Chinchipe, and Orellana. Plantations of this fruit crop are also found in the foothills of the mountains in Tungurahua, Pichincha, Imbabura, Carchi and Santo Domingo de los Tsáchilas Provinces, under various environmental and soil conditions (Revelo et al., 2010).

Naranjilla breeding

In late 1970s, the common naranjilla was displaced from its traditional cultivation areas due to pests (ECORAE-INIAP-OEA-GTZ, 2001). The environmental conditions gave rise to the progressive susceptibility to diseases such as vascular wilt caused by *Fusarium oxysporum* (Ochoa et al., 2010a), causing wilting and plant death (Figure 3); anthracnose (*Colletotrichum acutatum*), producing rounded spots of dark brown color and the mummification of fruits (Ochoa et al., 2010c) (Figure 4); blight (*Phytophthora* sp.) (Ochoa et al., 2010b); and bacterial wilt (*Ralstonia solanacearum*) (Revelo and Sandoval, 2003). Additionally, the nematode, *Meloidogyne incognita*, limits its cultivation. This nematode produces nodulations in the roots that reduce water and nutrient absorption and cause gradual weakening and plant death (Silva et al., 1986). The fruit borer (*Neoleucinodes elengantalis*) can cause up to 70% of fruit loss (Noboa et al., 2017).

Heiser (1989, 1993) described the limited conventional breeding, through the production of interspecific hybrids. The first naranjilla hybrid obtained in Ecuador was a cross of *S. sessiliflorum* (cocona) × *S. quitoense*, and was called 'Puyo' hybrid (Soria, 1997). This hybrid is highly productive and vigorous, however, its seeds are sterile. The plant must be reproduced by cuttings. In addition, hormone treatments of 2,4-dichlorophenoxyacetic acid (2,4-D) are used to increase fruit size (Camacho, 1981; Heiser and Anderson, 1999). Another hybrid, 'Palora', has larger fruit and was obtained by crossing *S. quitoense* (Baeza roja) × *S. sessiliflorum*. This cultivar does not require the use of 2,4-D, however, the color of the pulp is pale yellow while consumers prefer green pulp (Fiallos, 2000).

Since 2003, the Fruit Program of INIAP has been breeding naranjilla and has expanded resistance by using wild *Lasiocarpa* section species as rootstocks. These species are resistant to *F. oxysporum* and *M. incognita*. As a result, accessions of *S. hirtum*, *S. pseudolulo*

Figure 5. Naranjilla rootstock. A. *Solanum hirtum*, B. *Solanum arboreum*.

Figure 6. Fruit of 'INIAP Quitoense 2009'.

Figure 7. Different colors of the fruit pulp of naranjilla.

Figure 8. Variability of fruits of the population of the *S. hirtum* × *S. quitoense* cross.

and *S. arboreum* (Figure 5) that show resistance have been selected as rootstocks (Pujota, 2005; Viteri et al., 2007). In addition, INIAP has released 'INIAP Quitoense 2009' (Figure 6) through mass selection. This cultivar grafted on the *S. hirtum* and *S. arboreum* rootstocks has high yields, improved fruit quality, and greater plant longevity (Viteri et al., 2009; Navarrete et al., 2018). According to chemical analyses, fruit from this cultivar can have 2.0-2.51% citric acid, 53.33 mg 100 g^{-1} vitamin C, and soluble solids of 9.35-11.16 °Brix (Revelo et al., 2010).

Populations from *S. quitoense* × *S. hyporhodium* or × *S. vestissimun* have been assessed, looking for high soluble solids and pulp color (Figure 7) (Perachimba et al., 2004). The objective of crossing with wild relative species is to incorporate disease resistance genes (Báez et al., 2005; Pazmiño, 2008; Gómez, 2009). In addition, field evaluations of the interspecific hybrids in the northwest of Pichincha (Gómez, 2009) and in Morona Santiago Province in the Amazon (Silva et al., 2016) have been performed to develop resistance to *Fusarium* and nematodes, and produce high yield and fruit quality.

Because wild relative species can adapt to altitudes between 1500 and 2200 m (Whalen et al., 1981), hybrids have been evaluated in the

Figure 9. Tree tomatoes.

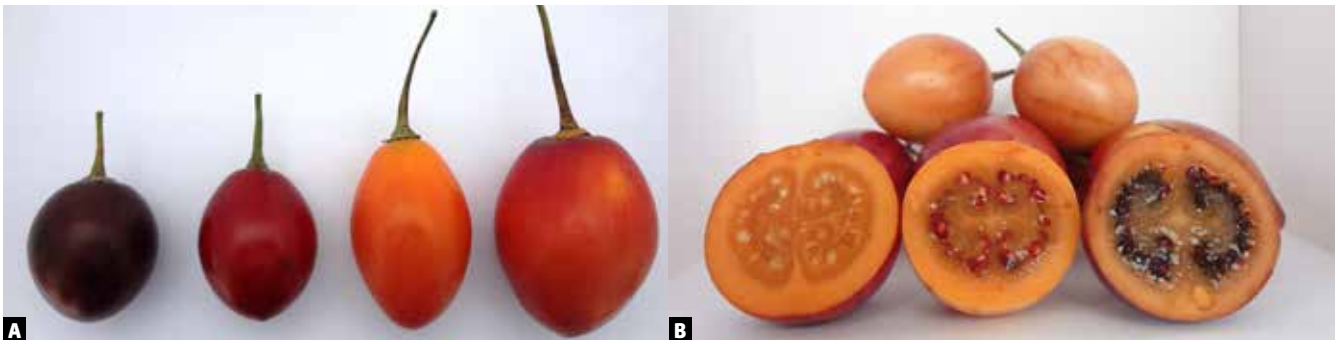

Figure 10. A. Cultivars of tree tomato. B. Colors of mucilage and pulp.

inter-Andean Tumbaco Valley located at 2348 m. This valley has an average temperature of 17°C and annual precipitation of 800 mm. Eight selections have been made (Bucheli, 2015). Populations from *S. hirtum* × *S. quitoense* crosses have also been assessed (Figure 8).

Tree tomato (*Solanum betaceum*)

Crop characteristics

Tree tomato (Figure 9) is an Andean fruit crop widely cultivated in Colombia, Ecuador, and Peru (Viera et al., 2016). Its origin is unknown, however, wild populations in southern Bolivia and northwestern Argentina are reported (Bohs, 1989). Northern Peru and southern Ecuador are considered as the center of domestication of this plant (Acosta-Quezada et al., 2012).

The plant grows from 1500 to 3000 m (Ramírez and Kallarackal, 2019). Tree tomato can reach 2-4 m. Its leaves are green, 20-40 cm long by 20-35 cm wide and showing pubescence on both sides. The inflorescence is branched with 10-50 flowers. Its flower is hermaphrodite, and the fruit is ovoid obtuse or acute at the apex, with skin color ranging from yellow, orange, or red to purple. On occasion dark longitudinal stripes are present on the skin (Lewis and Considine, 1999; Feican et al., 2016; Acosta-Quezada et al., 2016).

Different tree tomato cultivars are grown in Ecuador (Figure 10). These cultivars can be distinguished by the pulp color (orange and red) but also by chemical composition (Espín et al., 2016). This fruit has potential for export to foreign countries.

Tree tomato production is concentrated in the Ecuadorian Highlands by small and medium-sized producers. This fruit crop has an average yield of 10.35 t ha^{-1} (SIPA-SINAGAP, 2017). Tungurahua has the largest production area of 1285 ha. This fruit crop can reach a yield of 20 t ha^{-1} with optimal growing conditions (Acosta-Quezada et al., 2011).

In Ecuador, tree tomato plantations use grafted cultivars on rootstocks such as *Nicotiana glauca* or *S. auriculatum* (Figure 11). These rootstocks have resistance/tolerance to *F. oxysporum* and *M. incognita* (Viteri et al., 2009; Navarrete et al., 2018). Grafted plants protect scion from soil borne pathogens, improve yield through efficient nutrient assimilation, and prolong the commercial life of the clones (Martínez et al., 2010; Arizala et al., 2011; Vargas et al., 2018).

Tree tomato has great possibilities for export due to its excellent organoleptic characteristics. It has high ascorbic acid, pro vitamin A, carotenoids, vitamin B6, C, E, high antioxidant activity and mineral content. The fruit contains calcium, iron, and phosphorus (Belén-Camacho et al., 2004; Espín et al., 2016). Therefore, breeding research goals seek to improve these qualities for profitable production and commercialization.

Figure 11. Tree tomato rootstock. A. *Nicotina glauca*, B. *S. auriculatum*.

Tree tomato breeding

The cultivars lack quality and are susceptible to pests and diseases (Meza and Manzano, 2009; Carrillo-Perdomo et al., 2015). The main pests affecting this crop include blight (*Phytophthora* sp.), anthracnose (*Colletotrichum acutatum* and *C. tamarilloi*), stem black spot (*F. solani*), vascular wilt (*F. oxysporum*), oidio (*Oidium* sp.), alternariosis (*Alternaria* sp.), nematodes (*Meloidogyne incognita*) and virosis (León et al., 2004; Feican et al., 2016; Caicedo et al., 2017; Espinoza et al., 2017).

One of the main phytosanitary problems is the high incidence of anthracnose (Viera et al., 2016; Caicedo et al., 2017). This disease occurs at any age of the plant. In the fruits, the initial spot infection is black, sunken, and circular with defined edges. This advances rapidly and covers the fruit, which produces mummification (Falconi et al., 2013). Losses caused by this disease range from 50 to 100% (Figure 12) (Saldarriaga-Cardona et al., 2008).

Since 2006, the Fruit Program of INIAP has assessed inter-specific crosses between *S. betaceum* × *S. unilobum* and *S. betaceum* × *S. materna* (Figure 13). These species produce differential resistance to anthracnose, but have poor fruit quality in terms of size and flavor. Backcrosses were made with *S. betaceum* to recover the fruit quality (Proaño, 2008).

Table 1. Functional compounds and antioxidant capacity of hybrids of tree tomato.

Functional traits	Value
Total phenolics (mg gallic acid g^{-1})	5.11-13.42
Total flavonoids (mg catechin g^{-1})	1.54-6.70
Total anthocyanins (mg cyanidine-3-glycoside 100 g^{-1})	1.06-240.49
Total carotenoids (µg ß-carotene g^{-1})	157.28-460.72
Vitamin C (mg ascorbic acid 100 g^{-1})	78.29-428.16
Antioxidant capacity by FRAP ABTS (µmol trolox g^{-1})	52.43-169.61
Antioxidant capacity by ABTS (µmol trolox g^{-1})	49.51-131.79

Table 2. Chemical traits of 'INIAP Andimora 2013'.

Chemical traits	Value
Citric acid (g 100 g^{-1})	2.62
Protein (%)	11.11
Total carbohydrates (%)	77.42
Reducing sugars (%)	40.66
Polyphenols (mg g^{-1})	48.39
Magnesium (µg g^{-1})	2200
Phosphorus (µg g^{-1})	2400
Potassium (µg g^{-1})	21000
Manganese (µg g^{-1})	33

Figure 12. Fruit damage caused by *Colletotrichum acutatum*.

Figure 13. Tree tomato fruit variability resulting from the crosses.

Figure 14. Tree tomato materials susceptible to anthracnose. A. Commercial cultivar used as control, B. susceptible segregant material, C. segregant material showing tolerance to anthracnose.

Continuing with the breeding process, progenies from the backcross were selected, based on resistance to anthracnose and fruit quality (Coloma, 2010). Subsequently, fruit quality, fruit size, pulp, mucilage color, soluble solids content, acidity, and response to anthracnose were evaluated. Hybrids from [(*S. unilobum* × *S. betaceum*) × *S. betaceum*] × *S. betaceum* were compared with susceptible controls (commercial cultivar 'Orange Giant'). The evaluation was performed with natural infection. This allowed for the selection of promising materials (Viera et al., 2016).

To confirm the results, the hybrids were evaluated by pathogen inoculations of the fruit under controlled conditions (Figure 14). This procedure allowed for the selection of new parents for future crosses (Perachimba, 2018). A physical and functional characterization of 50 selected hybrids determined their content of functional compounds and antioxidant capacity (Table 1) (Camacho, 2019). Fruits were sampled at maturity.

Figure 15. Blackberry plantation showing the training system.

Figure 16. Fruit of 'INIAP Andimora 2013'.

Figure 17. Blackberry cultivars.

Blackberry (*Rubus glaucus*)

Crop characteristics

In Ecuador, more than 21 *Rubus* species have been reported (Romoleroux, 1991). The Castilla blackberry (*Rubus glaucus*) is native of the Ecuadorian and Colombian Andes (Viteri et al., 2016). The production of this fruit now includes Guatemala, Panama, and Mexico (Franco and Giraldo, 2002; Romoleroux, 1996; Popenoe, 1924). In Ecuador, Castilla blackberry is gathered from the wild or is cultivated along inter-Andean Valleys of the highlands between 2000 and 3100 m. This fruit crop has different productions systems involving mainly small and medium farmers (Herforth et al., 2015; Alwang et al., 2019; Martínez et al., 2019) This plant needs to be trained for best growth and production (Figure 15). This fruit crop is cultivated mainly in Tungurahua, Cotopaxi, Bolívar, Chimborazo, Pichincha, Imbabura and Carchi Provinces (Martínez et al., 2007; Jácome et al., 2016).

This fruit is a low-calorie fruit that is beneficial for human nutrition. The dark pigments of the fruit have antioxidant activity, due to the amount of total polyphenolic compounds such as bioflavonoids (48.39 mg g^{-1}). The fruit has high fiber content (5.3 g 100 g^{-1} of fruit), nutrient content and vitamin C (131.95 mg 100 g^{-1} of fruit). This fruit is widely accepted in the local market and has potential for export. Markets exist for both fresh and processed production (Carrillo-Perdomo et al., 2015).

In Ecuador, the average yield for blackberries is 6.8 t ha^{-1} (Viera et al., 2019), which is lower than that of Colombia, with yields from 8.8 to 20 t ha^{-1}, and USA with 25 t ha^{-1}. The other countries produce blackberry fruits from another species (Franco and Giraldo, 2002; García and García, 2001; Bejarano, 1992). Pest problems and adverse weather in some production areas can cause lower yields in Ecuador (Jácome, 2010).

Blackberry breeding

In 2008, INIAP began to rescue the genetic variability of *Rubus*. To this end, 108 accessions were collected. The samples included 78 cultivated accessions and 30 representatives of wild species, at altitudes between 1320 and 4200 m (Garrido, 2009).

With the use of microsatellite markers, inter simple sequence repeats (ISSRs) duplicate accessions of the collection were determined, leaving 29 accessions as part of the core collection. The remaining accessions were characterized with amplified fragment-length polymorphism (AFLP) markers. Two groups were distinguished. The first was conformed only by cultivated accessions. The second included non-cultivated accessions. In addition, the first group was further subdivided into accessions without thorns of Ecuadorian and Colombian origin, and Ecuadorian cultivated materials with thorns (Garrido, 2009).

Subsequently, morpho-agronomic characterization of the core collection was performed and quantitative and qualitative discrimi-

Figure 18. A. Blackberry branch without thorns. B. blackberry branch with thorns.

nant characters were identified. This allowed the selection of 14 promising accessions based on yield and fruit quality (Mejía, 2011). MA-0100 thornless was identified and evaluated during 2008-2012, showing high yield. This accession obtained up to 18 t ha^{-1} versus 6.8 t ha^{-1} of the traditional Castilla blackberry that was used as a control (INIAP, 2009, 2010, 2011, 2012, 2013).

In 2010, postharvest fruit quality was evaluated for 14 blackberry accessions, where MA-0100 accession showed good attributes such as high soluble solids content and storage for 7 days at room temperature and 12 days under controlled conditions of 2°C, in fruit harvested with 50% purple color (Brito et al., 2016).

In 2013, the Fruit Program released the first official blackberry cultivar called 'INIAP Andimora 2013', which had high yield and fruit quality and was thornless (Figure 16), providing an alternative to replace the commercial cultivars with thorns.

The fruit weight of 'INIAP Andimora 2013' ranged between 4.16 and 5.48 g, and had a firmness of 3.24 N. The cultivar reached 11.81% seeds and 88.19% pulp (Esparza et al., 2004). The minimum blackberry pulp yield required by the industry is 80%. The soluble solids value for the fruit was 12.60 °Brix, which exceeds 'Colombian' (8.5 °Brix) (NTC 4106, 1997). Chemical traits are described in Table 2; values that are high compared to several evaluated blackberry accessions (Montalvo, 2010).

INIAP's and other cultivars ('Castilla', 'Colombian', and 'Brazos') were compared with the objective of finding differential morphology (Figure 17). Through multivariate analysis, three clusters were formed. 'Andimora' and 'Colombian' (cluster 1) cultivars, which are thornless, unlike 'Castilla' (cluster 2) and 'Brazos' (cluster 3) that have thorns, with the latter being the most undomesticated material (Figure 18). 'Colombian' was the earliest cultivar (161 days from sprouting to harvest) and 'Castilla' the latest (186 days). 'Brazos' had the highest fruit weight (5.85 g). However, 'Andimora' reached high soluble solids content (11.86 °Brix) and had firm fruits (3.24 N). The mentioned characters have allowed establishing parameters of distinction among cultivars that are currently grown in Ecuador (Iza, 2018).

Conclusion

In conclusion, the breeding of Andean fruit crops has recently advanced but needs to continue to develop more new cultivars. At the moment, new cultivars are needed to improve Ecuadorian horticulture. The main goal of the INIAP fruit breeding program is to develop improved disease resistance of Andean horticultural crops. This is the predominant limiting factor that prevents optimal yields. The three Andean fruit crops mentioned in this report have potential for local and international commercialization due to their soluble solids content, antioxidants, vitamins and other nutritional compounds. These fruit quality characteristics can contribute to the production of safe food to improve global human health.

› William Viera

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› Pablo Viteri

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William Viera is currently the Research Director of the National Institute of Agricultural Research (INIAP) in Ecuador. He was the Fruit Program National Coordinator for research activities. He was also part of the National Department of Plant Protection of INIAP. His research has been focused on breeding of Andean fruit crops such as tree tomato, naranjilla, and blackberry. In addition, he has carried out research projects for agronomical management of avocado, peach, cherimoya, soursop, passion fruit and sweet passion fruit. He has developed the implementation of use of microorganisms (*Trichoderma* and mycorrhiza) in fruit crops in Ecuador. E-mail: william.viera@iniap.gob.ec

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Sustainable irrigation of date palms in the hyper-arid United Arab Emirates: a review

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Introduction

Dates (*Phoenix dactylifera* L.) are important for heritage, cultural, religious, and economic reasons in the Middle East, South Asia and North Africa. These regions are arid and hyper-arid and so the date palm-trees need to be irrigated. Traditionally, date palms were sustainably irrigated using groundwater resources. Since ancient times, in the United Arab Emirates (UAE) and across the Arabian Peninsula, so-called *aflaj* systems were used to supply water to irrigate the palms, *inter alia*. These *aflaj* systems drained groundwater from higher elevations under gravity through man-made tunnels eventually bringing the groundwater to the surface. From this now-surface source, water was then distributed through channels for irrigation, plus it was also used for household and religious purposes (http://whc.unesco.org/en/list/1207/). In classical Arabic, *aflaj* (the singular is *falaj*) means to 'split into parts'. Dates were traditionally grown in surface irrigated basins in which there was usually also a cover crop that could grow under the canopy of the date palms.

Groundwater remains the prime source of irrigation water in the regions, but due to increased demands for irrigation, and via modern pumping systems, it is under threat from declining quantity and rising salinity. Usage of groundwater now well exceeds the rate of natural replenishment in this hyper-arid region. While there are merits in seeking to improve the efficiencies of modern irrigation systems, regulatory solutions need to be found to protect the natural capital stocks of groundwater. Of fundamental importance is the need to determine the actual water requirements of date palms under these hyper-arid conditions. Here we review our work in the hyper-arid UAE on developing sustainable rates of irrigation that can be used for regulatory purposes. We also highlight the benefits that can accrue from using solar-power desalinated water to irrigate palm trees, as well as detailing the concerns that would ensue from the disposal of the reject brine from these desalination units.

Figure 1. A. One of the instrumented 'Lulu' date palms from the S1 treatment that was irrigated with water at 5 dS m^{-1}. The tree height was 3.6 m, and the irrigation bund surrounding the tree can be seen. B. One of the instrumented 'Lulu' date palms from the S3 treatment that was irrigated with water at 15 dS m^{-1}. The tree height was 2.6 m. The experimental site is at the International Center for Biosaline Agriculture near the city of Dubai, United Arab Emirates, and the photos were taken in 2014.

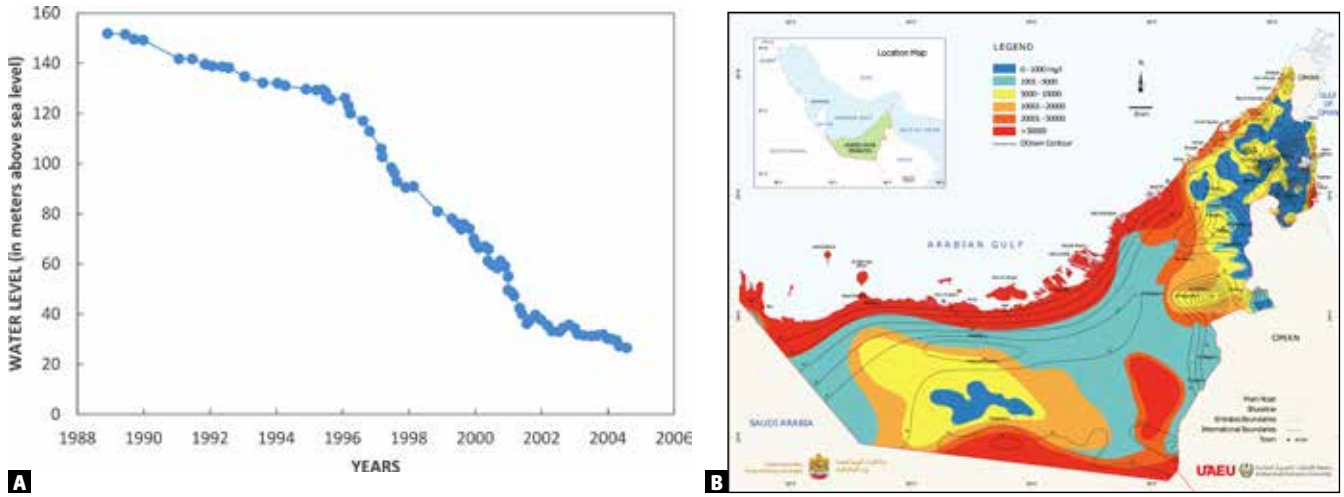
History of date farming and contemporary production

The date palm is an iconic symbol of desert life (Brouk and Fishman, 2016) (Figure 1). The date palm can withstand the hyper-arid environments of the desert because of its ability to tolerate extremely high temperatures, saline soil and water conditions, and severe droughts. Richards (1954) considered that the date palm was the most salt tolerant of any fruit crop. Therefore, it is one of the most important plants of the desert (Zohary and Hopf, 2000). The date palm delivers multiple ecosystem services to desert-oasis landscapes by providing nutritional, economic, social, religious, and heritage values (Zekri et al., 2010; Aly and El-Hewiety, 2011). It has been considered that "... had the date palm not existed, the expansion of the human race into hot and barren parts of the 'Old World' would have been much more restricted" (Barreveld, 1993). Brouk and Fishman (2016) considered that the date palm is "... one of the oldest trees from which man has derived benefit and it has been cultivated since ancient times". One adage has it that the date palm "... has its feet in running water and its head in the fire of the sky".

Today, the top six date producing countries are, according to the Food and Agriculture Organization of the United Nations (FAO, 2017), in declining order: Egypt, Iran, Algeria, Saudi Arabia, Pakistan, and the UAE. Groundwater is mainly used to irrigate date palms in these hyper-arid and arid climes (Zaid and Arias-Jimenez, 2002), yet groundwater resources are under great pressure in these Middle Eastern, South Asian and North African countries.

Dates, water resources, and irrigation practices in the UAE

Rashoud (2016) suggested that the connection between the people of the UAE and the date palm is deeply rooted in the ancient past. In 2006, five Omani *aflaj* were granted UNESCO World Heritage Site status. These, and other



■ Figure 2. A. In the so-called 'red-zone' surrounding Al Ain, there has been over 100 m of decline in the groundwater level. B. A contour isoline map of the decline in the depth to groundwater in metres in the United Arab Emirates, along with the increases in the salinity of the underlying aquifers in mg L^{-1} between 1969 and 2012 (colour coded). Source: MOEW (2014). Reproduced with the permission of the Ministry of Climate Change and Environment (MOCCAE) and the United Arab Emirates University (UAEU).

aflaj, may date back to 500 CE (Common Era). Although archaeological evidence suggests that such irrigation systems may have existed on the Arabian Peninsula as early as 2500 BCE (Before Common Era). Yet Rashoud (2016) asserts that the strength of the bond between this 'blessed' tree and Emiratis remains ever strong today. The UAE has more than 40 million date trees, with over 200 cultivars, and nearly 70 of these are of commercial importance (Jaradat and Zaid, 2004). Modern drip and bubbler systems are used to supply pumped-groundwater to the individual basins around the date-palm trees (Figure 1).

Irrigation of date palms accounts for nearly one-third of groundwater withdrawals in the UAE (MOEW, 2015). Wada et al. (2012) calculated that 64% of the total irrigation demand in the UAE comes from non-renewable groundwater resources. There are grave concerns about the rapidly declining levels of groundwater tables in the UAE, especially in the Al Ain region of eastern Abu Dhabi (Figure 2A). In addition, the salinity of the remaining groundwater reserves is rising (Figure 2B). This rise in groundwater salinity is of concern, for Zekri et al. (2010) found that in Oman when the salinity of groundwater used for irrigation rose from an electrical conductivity of 5 to 15 dS m^{-1}, the gross economic margin of date production dropped by one-third. In 2017, in response to these burgeoning concerns about groundwater quantity and quality, Environment Agency – Abu Dhabi (EAD) announced the new Law 5 (2016), on the "Regulation of Groundwater in the Emirate of Abu Dhabi" (Figure 3). Law 5, which has come into force, asserts that the Government of Abu Dhabi owns the groundwater resource. In addition, Law 5 requires extraction limits be set for groundwater usage according to the proposed crop for which the water will be used to irrigate.

Under the auspices of EAD, we have completed four years of research on the water use of date palms to enable development of practical advice to growers on the sustainable use of saline groundwater to irrigate dates (Figure 4). We have also provided the requisite institutional and regulatory aspects of irrigation of date palms.

Here, we provide an overview of our Emirati research and present the key findings. The scientific details of this research have been published in Al-Yamani et al. (2017), Al-Muaini et al. (2018), and Al-Muaini et al. (2019a, b, c, d). The present review focuses on this work in the UAE only. However, in the aforementioned papers, we reference other international research on the water use of dates and, for completeness, we cite these here: Chao and Kreuger (2007), Madurapperuma et al. (2009), Roupsard et al. (2006), Sellami and Sifaoui (2003), Smith (1989), Sperling et al. (2012, 2014), Tripler et al. (2011), and Zhen et al. (2019).

Measuring and predicting palm-tree water use

The experiments we are reviewing here were carried out during 2014-2017 at the International Center for Biosaline Agriculture (ICBA) (25.09°N, 55.39°E, 48 m a.s.l.) near the city of Dubai. The ICBA date trial originally commenced in 2001 and 2002 and considered 18 cultivars. The 18 cultivars encompassed a wide range of tolerances to salt. Our detailed water-use studies considered the salt-tolerant 'Lulu', an Emirati cultivar (Figures 1 and 4), as well as the moderately salt-tolerant 'Khalas' from Saudi Arabia, and the salt-intolerant 'Shahlah' from the UAE. The ICBA trial considers three rates of irrigation water salinity: Block S1 = 5, S2 = 10 and S3 = 15 dS m^{-1}. Over four years, the hourly pattern of tree water use, *ETc* (L h^{-1}), was measured using the

■ Figure 3. Law 5 of 2016 concerning the "Regulation of Groundwater in the Emirate of Abu Dhabi". The objective of this law is the management of groundwater in the Emirate (in Arabic).

compensation heat pulse method (CPHM) in just the two treatments S1 and S3 for each of the three cultivars. Details of the use of the CPHM in date palms have been described by Al-Muaini et al. (2019a). All the date palms were planted on an 8×8 m grid spacing. This enabled the daily water-use totals in L d^{-1} to be converted to units of mm d^{-1}, as required.

A weather station located at ICBA was used to estimate hourly and daily values of the reference evapotranspiration (*ETo*) using the standard FAO-56 approach (Allen et al., 1998). The transpiration of the date palms is related to ET_o through the dimensionless crop factor, *Kc*, as follows: *ETc* = *Kc* * *ETo*, where *ETc* is the crop water use (L d^{-1}) and *Kc* is determined

Table 1. The effect of two rates of irrigation-water salinity on the annual tree water use (*ETc*), light interception (*LI*), and the crop factor (*Kc*) of three date cultivars at the International Center for Biosaline Agriculture (ICBA) near Dubai, United Arab Emirates. Also given are the respective ratios of *Kc/LI* (adapted from Al-Muaini et al., 2019b).

Cultivar	Irrigation salinity (dS m^{-1})	Annual ETc (kL $year^{-1}$ $tree^{-1}$)	Light interception (LI)	Crop factor (Kc)	Ratio Kc/LI
Lulu	5	50.0	0.26	0.31	1.19
	15	28.4	0.20	0.17	0.85
Khalas	5	43.1	0.31	0.26	0.84
	15	23.2	0.19	0.14	0.74
Shahlah	5	57.3	0.34	0.35	1.03
	15	31.1	0.18	0.19	1.06
Average					0.95

from the ratio of the measured daily sap flow to the reference *ETo*. In the UAE, the annual *ETo* exceeds 2000 mm $year^{-1}$, whereas average annual rainfall (*RF*) is just 50 mm $year^{-1}$. The climate is classified as hyper-arid since *RF/ETo* is less than 2.5%.

Our measurements of *ETc* and *ETo* enabled us to compute the daily pattern of *Kc* over several years for the three cultivars and the two rates of irrigation-water salinity. In Figure 5, we show how we found that the crop factor for the 'Lulu' S1 palms was 0.3.

The annual *ETc* and *Kc* results are given in Table 1, for all three cultivars across the two salinities of the S1 and S3 treatments. The palm-tree water use, *ETc*, ranged from 57.3 kL $year^{-1}$ $tree^{-1}$ ('Shahlah', S1) down to 23.2 kL $year^{-1}$ $tree^{-1}$ ('Khalas', S3). The crop factors, *Kc*, spanned the range from 0.35 down to 0.14 for these trees, respectively.

Table 1 reveals the complex effect of irrigation-water salinity and cultivar salt-tolerance on the water use of date palm trees.

The average yield of the S3 palms was 37 kg dates $tree^{-1}$, whereas the S1 trees yielded 74 kg $tree^{-1}$.

Matching irrigation to palm-tree water use

The challenge is to use this knowledge of these complex interactions to develop a policy recommendation for irrigation allocation that can be used in Abu Dhabi's Law 5.

We focused on the leaf area of the canopy, the prime driver of *ETc*, to develop a recommendation for Law 5. The rate and amount of water a palm-tree uses, under given ambient atmospheric conditions, is critically dependent on the leaf area of the palm-tree's canopy (Table 1). As a result of our observations of soil salinity conditions in the rootzone of irrigated date palm trees (Al-Muaini et al., 2019a, c), we considered that irrigation at the rate of 1.5 *ETc* would ensure sustainability. We considered this ratio of 1.5 would account for a 25% factor-of-safety, plus a 25% salt-leaching fraction. We found the 50% add-on to be sufficient to ensure that the saline groundwater used for 'today's' irrigation flushed out the excess salts left after the palm tree had osmotically removed 'fresh' water from the soil on the previous day to sustain its growth.

Our results came from the ICBA trial at an 8×8 m spacing. Not surprisingly, not all date farms in the UAE have trees at this spacing, and nor do they use the same pruning protocols for canopy management. Therefore, we needed to be able to extrapolate our 'research plot' findings to cover 'commercial farms'. To do this, we re-focused our research on improved measurement of the trees' canopy area. The key, we thought, was an ability to measure the projected shadow area the canopies cast on the soil surface. We developed a 'light stick' for this, which is a bar about 1 m long with 20 PAR (photosynthetically active radia-

Figure 4. Dr. Ahmed Al-Muaini downloading data from the instrumented 'Lulu' date palms of the low salinity treatment (5 dS m^{-1}) at the International Center for Biosaline Agriculture near the city of Dubai, United Arab Emirates.

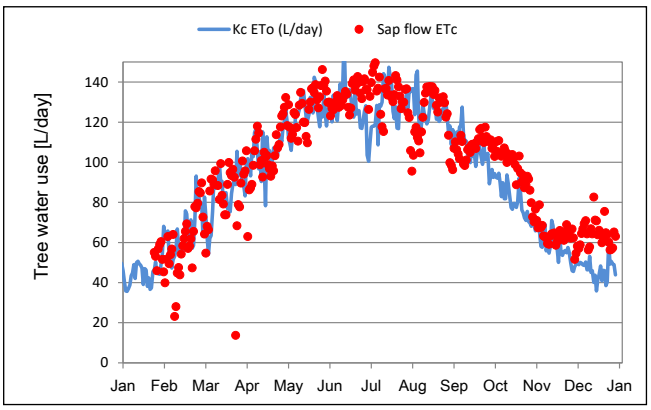


Figure 5. The average, measured daily tree water use, *ETc* (L d^{-1}) of three date palm trees (*Phoenix dactylifera* 'Lulu') at the International Center for Biosaline Agriculture near the city of Dubai, United Arab Emirates, as measured by the compensation heat-pulse method (red dots) over the full year 2014 for treatment S1 (5 dS m^{-1}). The model predictions are the calculation from the FAO-56 method, *ETc* = *Kc* * *ETo*, using the daily reference evapotranspiration *ETo* (L d^{-1}) and a crop factor *Kc* of 0.3. The three low daily values in February and April were rainy days. The dips in the measured *ETc* during early August and early September were because of problems with the operation of the irrigation system.

Figure 6. The light stick being used to measure the light interception fraction (*LI*) of the cultivar 'Shahlah' under the high salinity treatment S3 (15 dS m^{-1}). The light stick is 1 m long and comprises 20 equi-spaced quantum sensors that record photosynthetically active radiation at 2 Hz.

tion) sensors along it (Figure 6).

From the light stick, through multiple transects, we could calculate the light interception, *LI* (-), by the trees' canopies (Al-Muaini et al., 2019b). These *LI* results for our ICBA experiments are given in Table 1, and reflect the effect of both soil salinity and cultivar tolerance. The data range from 0.34 ('Shahlah', S1) down to 0.18 ('Shahlah', S3) as salinity and salt tolerance control canopy leaf area.

Goodwin et al. (2015) found that the ratio of *Kc* to *LI* was 1.2-1.3 for temperate fruit crops, such as apples and pears. However, for the salt-tolerant and drought-resistant palm trees here, we found the ratio, *Kc*/*LI*, to be just 0.95 (Table 1).

The challenge was then to extend these *Kc*/*LI* ratio results to the more than 110,000 commercial date farms in Abu Dhabi. One option would be to embark on a campaign to quantify, using the light stick, the canopy characteristics of palm-tree canopies on commercial farms. But we needed to simplify this even further.

Using Google Earth Pro™ we were able to link the fractional ground cover (*FGC*) of date-palm images to *LI* across 10 commercial farms (Figure 7) and our ICBA experiments. We found that the *Kc* value could be linked to *FGC*, such that *Kc* = 0.78 *FGC* – 0.08.

Using Google Earth Pro™, we could predict the *ETc* of date palms on the 10 commercial date-palm farms near Al Ain, and along the Liwa Oases. The probability distribution function of the water-use values is shown in Figure 8. With high-density plantings and only moderate pruning strategies, the *FGC* can approach unity, or full canopy cover. Under these conditions, the tree water-use *ETc* can exceed 100 kL $year^{-1}$.

The regulated water allocation of Law 5 should then be 1.5 *ETc*, although there needs to be encouragement to develop pruning practices to reduce canopy leaf area, without reducing date yields.

As a final stage of this project, we considered the benefits and implications of using solar-powered desalination units (Burn et al., 2015; Dawoud, 2017) to dilute the saline groundwater being used for the irrigation of date palms. We found the cost of using this process to dilute 15 dS m^{-1} groundwater to 5 dS m^{-1} irrigation water was UAE dirhams (Dhs) 275 $tree^{-1}$ (1 Dhs = US$0.27 in September, 2019). The yield benefit was 38 kg $tree^{-1}$ between the 15 and 5 dS m^{-1} salinities (Al-Muaini et al., 2019c). At Dhs 10 kg^{-1} for the price of dates, this means that the benefit-cost ratio of using desalinated water is 1.4. A valuable economic proposition. So the economic, cultural and heritage value of producing dates could be sustained using solar-powered desalination units.

However, this avoids the environmental concerns about the fate of the reject brine from desalination units in inland desert areas. Solutions for the use and disposal of the reject brine need to be found.

Future options

There are future opportunities for maintaining the production of dates in the hyper-arid deserts of Abu Dhabi. These involve the use of new technologies and novel economic opportunities involving desalination of brackish groundwaters. Simple benefit-cost assessments seem to suggest that the use of solar-powered desalination may be worthwhile.

Nonetheless, there must be sustainable solutions found for safe disposal of the reject brines that this solution offers. The opportunities created through the use of highly treated municipal-sewage effluents to augment the irrigation with groundwater of date palms must also be addressed. Critically, this will require socio-cultural assessments of the sustainability of using treated waste-waters to produce food of cultural, heritage and religious significance. There are many opportunities, and many threats, to the sustainability of date production in the hyper-arid and arid regions of the Middle East, South Asia and North Africa.

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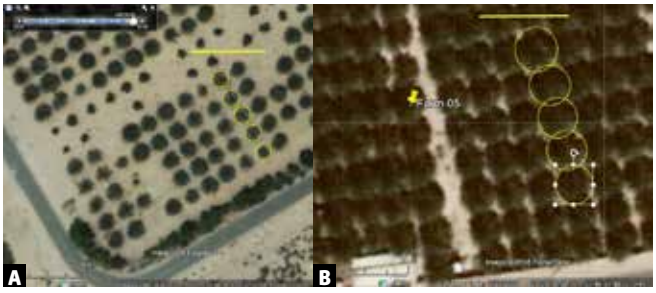

Figure 7. A. Google Earth image of part of the plantation of dates at the International Center for Biosaline Agriculture at which our experiments were carried out. The encircled trees are of the cultivar 'Shahlah' under the treatment S3 (15 dS m^{-1}). B. Google Earth image of a commercial date farm from the Liwa Oases. The circles show the approximate outlines of the trees' projected canopy areas. The yellow bar is a scale representing 28 m. The GIS image database was used to infer the fractional ground cover for these, and other farms.

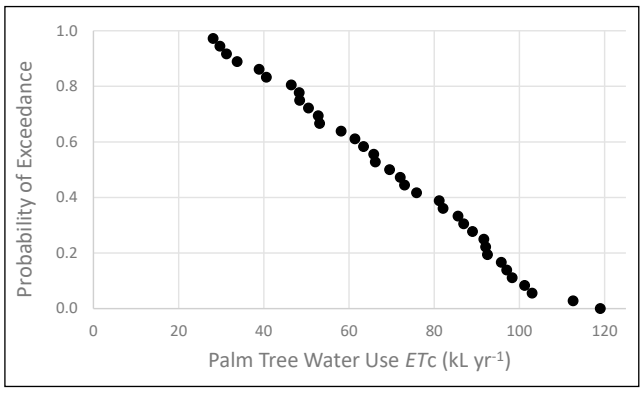

Figure 8. The probability distribution function of tree water use, *ETc* (kL $year^{-1}$) calculated for a wide range of date palms from 10 commercial farms in the Emirate of Abu Dhabi. The annual tree water use has been calculated using daily climate data for the reference evapotranspiration, *ETo* (mm d^{-1}), combined with a crop coefficient, *Kc*, as estimated from *LI* is light interception fraction being predicted from the fractional ground cover (*FGC*), determined from satellite imagery (modified from Al-Muaini et al., 2019d).

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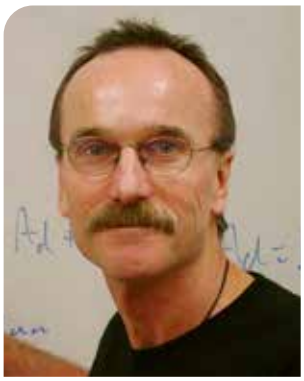

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The following are non-ISHS events. Be sure to check out the Calendar of ISHS Events for an extensive listing of all ISHS meetings. For updated information, log on to www.ishs.org/calendar

Advanced Course on Statistical Tools for Plant Phenomic Data Analysis, 20-24 January 2020, Zaragoza, Spain. Info: Mediterranean Agronomic Institute of Zaragoza (IAMZ) – CIHEAM, Avenida de Montañana 1005, 50059 Zaragoza, Spain, phone: +34 976 716000, fax: +34 976 716001, e-mail: iamz@iamz.ciheam.org, web: www.iamz.ciheam.org

V International On-line Course on Postharvest & Fresh-Cut Technologies, 1 February – 30 September 2020. Info: Dr. Francisco Artés-Hernández, Postharvest & Refrigeration Group, Universidad Politécnica de Cartagena, Paseo Alfonso XIII, 48, 30203 Cartagena, Murcia, Spain, e-mail: postharvest@upct.es, web: www.upct.es/gpostref/

Advanced Course on Use of Sensors in Precision Agriculture, 3-8 February 2020, Zaragoza, Spain. Info: Mediterranean Agronomic Institute of Zaragoza (IAMZ) – CIHEAM, Avenida de Montañana 1005, 50059 Zaragoza, Spain, phone: +34 976 716000, fax: +34 976 716001, e-mail: iamz@iamz.ciheam.org, web: www.iamz.ciheam.org

International Horticulture Conference, 26-28 February 2020, Lahore, Pakistan. Info: Dr. M. Shafiq, phone: +923006561997, e-mail: ihc.2020@pu.edu.pk, web: http://www.pshsciences.org/events/

Advanced Course on Technological Innovation for Intensive Greenhouse Production, 9-13 March 2020, Almería, Spain. Info: Mediterranean Agronomic Institute of Zaragoza (IAMZ) – CIHEAM, Avenida de Montañana 1005, 50059 Zaragoza, Spain, phone: +34 976 716000, fax: +34 976 716001, e-mail: iamz@iamz.ciheam.org, web: www.iamz.ciheam.org

Advanced Course on Greenhouse Gas Assessment and Mitigation in Agriculture: Concepts, Methods and Simulation Tools, 30 March to 3 April 2020, Zaragoza, Spain. Info: Mediterranean Agronomic Institute of Zaragoza (IAMZ) – CIHEAM, Avenida de Montañana 1005, 50059 Zaragoza, Spain, phone: +34 976 716000, fax: +34 976 716001, e-mail: iamz@iamz.ciheam.org, web: www.iamz.ciheam.org

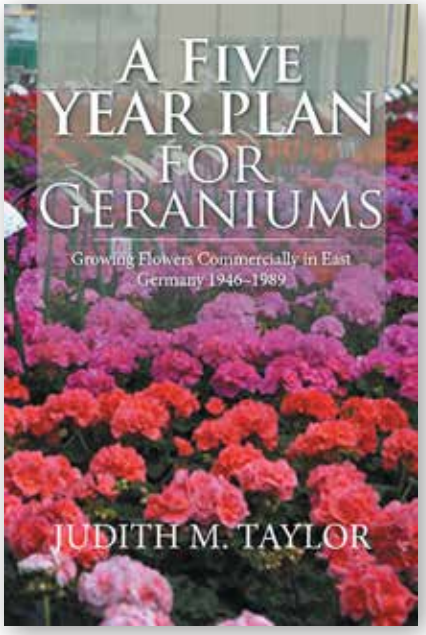
X Rosaceae Genomics Conference, 31 March - 3 April 2020, Barcelona, Spain. Info: Pere Arús & Amparo Monfort, IRTA (Institute for Food and Agriculture Research and Technology), Centre for Research in Agricultural Genomics (CRAG), CSIC-IRTA-UAB-UB, Edifici CRAG - Campus UAB, 08193 Cerdanyola del Vallès, Barcelona, Spain, phone: +34 932212242, e-mail: ariadna@geyseco.es, web: http://rosaceaegenomics.com/

XVI International Peatland Congress, 14-20 June 2020, Tallinn, Estonia. Info: Estonian Peat Association, e-mail: info@ipc2020.com, web: https://www.ipc2020.com/

› New books, websites

Book reviews

The books listed below are non-ISHS-publications. For ISHS publications covering these or other subjects, visit the ISHS website www.ishs.org or the *Acta Horticulturae* website www.actahort.org



Taylor, J.M. (2019). A Five Year Plan for Geraniums – Growing Flowers Commercially in East Germany 1946-1989 (Bloomington IN, USA: Xlibris), pp.215. ISBN 978-1-9845-7618-7 (hardback) / 978-1-9845-7617-0 (paperback) / 978-1-9845-7616-3 (e-book). $29.99 (hardback) / $19.99 (paperback) / $3.99 (e-book). www.xlibris.com

This book contains nine chapters that describe horticultural development in three areas of East Germany: a) Saxony, b) Thuringia and c) Saxony-Anhalt. The author begins with a thorough introduction, concerning the political situation of Europe in the first half of the 20th century. The first and second world wars together with the Russian revolution are described from the point of view of their effects on horticulture in Germany.

The history of German horticulture is outlined in subsequent chapters, starting from Goethe and his contributions, including his profound botanical knowledge, and his sensitivity to art and culture. The book stresses that the impact of horticulture in these areas has its roots in both the favorable climatic conditions of the regions and the presence of well-known horticulturists who gave input into the introduction of different species and educational programs. These positive conditions led to the important impact of horticulture in the period between the two world wars. Plenty of horticultural species were produced then including cut flowers and development of gardening. At this time, many nurseries shifted towards vegetable production.

The author then describes the further evolution in the post-war peace period, from 1945 to now. The historical period during which Germany was kept separated in two different geographical areas, the west and east, was described in particular. The book highlights that the political and social conditions of a country can greatly modify the productive activity. Indeed, during the iron curtain period, the majority of the nurseries were nationalized, and the whole horticultural production system was changed. The entrepreneurial initiative and innovation remained stifled in a period in which, under the socialistic influence and regime, the country's economy was planned on the basis of the "reason of state." Thirty years ago, as a consequence of the German reunification, horticulture was refueled and increased its development and impact not only in Europe but also in the whole world. However, the damages caused by the second world war, including the division of Germany, left a mark. Many companies could not resume their activities and the challenges connected with globalization (labor end energy costs) put German and European nurseries under stressful competition.

A list of important farmers and growers is presented in the book, including a description of their lives and contributions to the German horticultural rebirth. Farmers and growers are mentioned who simply believed in horticulture and in their country, and dedicated their lives to making Germany great.

In conclusion, this book is a wonderful reference that should be acquired by public and private libraries, because it shines new light on the 20th century history of horticulture in Germany; one of the most important European countries.

Reviewed by Margherita Beruto,
Chair of ISHS Division Ornamental Plants

New titles

Xu, X., and Fountain, M., eds. (2019). Integrated Management of Diseases and Insect Pests of Tree Fruit (Cambridge, UK: Burleigh Dodds Science Publishing), pp.748. ISBN 9781786762566 (hardback). £210.00.

A 20% discount will be received by entering the code "IPMTF20" when ordering through https://shop.bdspublishing.com/store/bds/detail/workgroup/?id=3-190-82511

› XXVI International EUCARPIA Symposium Section Ornamentals: Editing Novelty

Division Ornamental Plants #ishs_dorn
Division Protected Cultivation and Soilless Culture #ishs_dpro

The XXVI International EUCARPIA Symposium Section Ornamentals with the theme "Editing Novelty" was held from 1 to 4 September 2019 at the University of Applied Sciences Erfurt (FH Erfurt), Germany. The symposium was organised by the Erfurt Research Centre of Horticultural Crops (FGK) in partnership with the European Association for Research on Plant Breeding (EUCARPIA) and the International Society for Horticultural Science (ISHS). Financial support was received from the German Research Foundation (DFG).

The FGK was established in January 2019. Located at the FH Erfurt, the research centre is also closely connected to the Friedrich Schiller University in Jena, Germany. This permits work on questions of current and future challenges of horticultural practices with approaches and methods of modern biosciences. More information can be found at https://www.fh-erfurt.de/lgf/en/forschung/fgk/.

After registration, placing of posters and welcome reception on the first day, the scientific part of the symposium started with a session on morphogenesis. In this session, we learned how the ABC model of flower development derived from *Arabidopsis* has to be modified for transfer to different ornamental crops. An important topic in the production of ornamentals is to induce particular morphological phenotypes. One presentation showed that synthetic inhibitors can be exchanged by the use of rhizogenic bacteria to achieve compact growth.

The second session was dedicated to modern breeding techniques. After oral presentations about the state of the art, the global regulations of genome-edited plants from the scientific and from the regulatory point of view were discussed. An essential outcome was that scientists have to better inform the public about any chances or risks of genetic engineering. This technique is already used globally for a number of other production processes without attracting attention.

An important trait in the breeding of ornamental crops is the resistance to pathogens and parasites. In the third session, different approaches were presented that included genes encoding susceptibility factors, phytohormones involved in stress responses, the crosstalk between different signal transduction pathways and the interaction of plants with rhizosphere communities.

› The organisation team of the FGK.

The biodiversity of flowering plants is incredibly high and, we could see in the fourth session that hundreds of Mexican species, for example, have potential as new ornamental crops. This seems to be more possible with the steadily improving techniques of modern biosciences. This potential development has to be regulated fairly for the benefit of the owners of the natural resources and of the entities that organise and finance the process. The current state of the art in the negotiations of the Nagoya protocol was reported by an expert and discussed by the participants of the symposium.

Ploidy mutations are another source of variation especially important in ornamental crops. This is a challenge in breeding but can be managed if ploidy levels have been identified. One step forward would be the manipulation of haploidisation and polyploidisation. Molecular biology and genetic approaches could pave the way to this task, and newest results in this direction were presented in the fifth session.

Inter- and intraspecific hybridisation is not only a driving force in evolution, but also a highly successful approach for the generation of diversity and for the combination of traits. Newly developed methods help to bridge difficult gaps. Many examples of techniques and applications were shown in two presentations of the seventh session and new methods of karyotyping for analysing the outcome of hybridisation were described in two other talks.

A break-through in biological sciences is that sequencing of genomes and transcriptomes became much faster and much less expensive during the last years. It is therefore now possible to get the data not only from cash crops, but also from species that are important for horticulture. The rose genome was presented in the last session of the symposium, and it was shown in several presen-

› Participants of the symposium.

tations how this rich data pool can be used together with high linkage maps and association studies to breed for disease resistance or for flower traits. Sequenced genomes are already available also for petunia and it can be expected that more and more ornamental crops will follow giving highly improved bases for molecular breeding.

More than 100 scientists (appr. 40% from horticultural enterprises) from America, Asia, and Europe discussed the presentations after the talks, in the poster sessions and in the breaks. The book of abstracts can be downloaded at https://www.eucarpia-ornamentals2018.org/book-of-abstracts-eucarpia-syposium-section-ornamentals. Full text papers of selected presentations will soon be published in *Acta Horticulturae*. In the closing session, the nine travelling grants from EUCARPIA for students were announced. Young Minds Awards of the ISHS were granted to two young scientists for their excellent presentations: Alejandro Thérèse Navarro from Wageningen University & Research, The Netherlands, for the best oral presentation entitled "QTL analysis in multiparental polyploids populations", and Shusheng Wang from Flanders Research Institute for Agriculture, Fisheries and Food (ILVO), Belgium, for the best oral presentation entitled "Effects of soil physico-chemical properties on the distribution of *Rhododendron* species in China".

Finally, I want to take the chance to thank the ISHS, EUCARPIA, the DFG and the FH Erfurt for their support, the colleagues at the FGK for their engagement and all participants for making the symposium such an interesting and lively event.

Philipp Franken

› Contact

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› Poster session.

› From left to right: Margherita Beruto, Chair of ISHS Division Ornamental Plants, the two winners of the ISHS Young Minds Award, Alejandro Thérèse Navarro and Shusheng Wang, and Philipp Franken, head of the FGK.

› IX International Symposium on Irrigation of Horticultural Crops

Division Physiology and Plant-Environment Interactions of Horticultural Crops in Field Systems #ishs_dphy
Division Protected Cultivation and Soilless Culture #ishs_dpro
Division Temperate Tree Fruits #ishs_dfru
Division Vegetables, Roots and Tubers #ishs_dveg
Division Vine and Berry Fruits #ishs_dvin

The International Society for Horticultural Science (ISHS) and the University of Basilicata conveners, Prof. C. Xiloyannis and Prof. B. Dichio, organized the IX International Symposium on Irrigation of Horticultural Crops in Matera, Italy, from 17 to 20 June 2019 at the venue of the new campus of the University of Basilicata.

Today the competition for scarce water resources in many places at global level is intense. Available freshwater resources are constantly diminishing at increasing rates. Adaptation of agriculture to varying and extreme conditions induced by climate change is necessary because some changes in climate can no longer be prevented.

The aim of the ISHS is to address drought issues, especially in countries most affected by water scarcity, and ISHS is encouraging its members to find solutions to mitigate the adverse effects of drought. Along this line, a new session (Session 1) was dedicated to "Climate and water resource perspectives: social and economic aspects", including keynote speakers from several international institutions involved in water management and supply (FAO, ICID, UNCCD, CIHEAM-IAM, IWMI) (videos of the first day of the symposium are available at http://irrigationmatera2019.com/video/). This first session was appreciated by participants and it helped to better define the discussion of the following sessions and the new research challenges.

More than 190 contributions (67 oral and 130 poster presentations) were presented during this symposium, divided into the following seven sessions (from Session 2 to 8):

- Non-conventional water use: saline and urban wastewater;
- Evapotranspiration, irrigation requirement and modeling;
- Water relations, soil and plant water stress assessment;
- Sensing technologies relevant to precision irrigation;
- Tree crop irrigation management (drought and fruit quality);
- Vineyard irrigation: grape and wine quality;
- Irrigation of herbaceous crops and ornamental plants – open fields and greenhouses.

The symposium attracted about 200 participants from 29 countries all over the world, representing Argentina, Australia, Belgium, Canada, Chile, China, Cyprus, Czech Republic, France, Germany, Greece, Hungary, Israel, Italy, India, Latvia, Luxembourg, Morocco, New Zealand, Norway, Philippines, Portugal, Serbia, South Africa, Spain, Switzerland, Turkey, United Kingdom, and United States of America. In addition, approx. 50 sponsor technician delegates (25 from exhibitors and 25 from sponsors) and five media partner delegates (one from the international media partner) joined the symposium.

› Matera is a UNESCO World Heritage site and the 2019 European Capital of Culture, a model city in water cycle, collection and storage. It is the first inhabited zone dating from the Paleolithic period, while later settlements bear witness of a number of significant stages in human history, perfectly adapted to its terrain and ecosystem.

› Participants of the symposium.

The symposium programme consisted of plenary lectures, scientific sessions (oral and poster presentations), a specialized field excursion in the Metapontino area, and a social event.

Contributions covered a wide range of research fields and their results highlighted the importance of plant physiological knowledge in order to assure a sustainable irrigation management oriented to satisfy plant water requirements, or to manage the level of stress established for the plants. In addition, the monitoring of the ongoing plant and soil water status into the field is necessary, in particular under arid and semi-arid conditions. The decision support systems (DSS) are promising tools for precision agriculture.

The symposium highlighted one of the important challenges for scientists, which

› From left to right: Prof. Giuseppe Montanaro, Dr. Joan Girona, Dr. Alon Ben-Gal, Prof. Bartolomeo Dichio and Dr. Werner Herppich presenting the ISHS Young Minds Awards to A) Inês Cabral for the best oral presentation, B) Gaia Pasqualotto for the best poster.

is to increase and facilitate the transfer of innovations and technologies to the end-users. Encouraging scientists, technicians and farmers to work together is thus a necessity. Along this line, during the same days of the symposium, the organizers realized also the "Festival of Innovation on Water and Irrigation" to involve farmers' organizations, networks at national and international level, and key actors of the latest technologies and innovations. This Festival was addressed both to technicians and scientists from all over the world discussing the technical aspects through thematic workshops, training and networking activities.

This parallel event presented a new organization format for the "International Symposium on Irrigation of Horticultural Crops" that received endorsement from the scientific world, considering the important connections between the research and technical aspects.

On June 20th, a commission composed of Joan Girona (IRTA, Spain), Alon Ben-Gal (Gilat Research Center, Israel), Werner Herppich (Leibniz-Institute, Germany) and Giuseppe Montanaro (University of Basilicata, Italy) awarded the "best oral and poster presentations" selected among young scientists. The two ISHS Young Minds Awards were the following:

- Total oral eligible contributions: 5
  Best oral ISHS Young Minds Award went to Inês Cabral (University of Porto, Portugal) for the presentation entitled "Effects of different deficit irrigation strategies on yield components and must quality of cultivar 'Touriga Franca' (*Vitis vinifera* L.) under Mediterranean climate conditions in Douro Region", by I. Cabral, A. Carneiro, T. Nogueira and J. Queiroz.
- Total poster eligible contributions: 9
  Best poster ISHS Young Minds Award went to Gaia Pasqualotto (University of Padova, Italy) for the presentation entitled "Canopy conductance of hazelnut orchards appeared relatively insensitive to different irrigation regimes", by G. Pasqualotto, V. Carraro, E.S. Huerta, M.J. Lisperguer, T. De Gregorio and T. Anfodillo.

The symposium was very successful. It was an opportunity for participants to rekindle common interests, allow for the exchange of knowledge and development of plans for future collaborations. In addition, participants enjoyed city tours and the cultural programme of the Festival. The Organizing Committee would like to thank all the people who contributed to the success of the symposium, particularly the main sponsors (Netafim, Orogel and Irritec), the gold sponsors (Grena and Bosch), and the silver sponsors (Arpor, Assofruit Italia, Panagri, and Plastic Puglia Irrigation Systems) for their support and collaboration in the carrying out of the event.

Bartolomeo Dichio, Alba N. Mininni and Cristos Xiloyannis

› Opening ceremony of the IX International Symposium on Irrigation of Horticultural Crops.

› Contact

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› Field visit in the Metapontino area: A) irrigation water supply system at farm level, B) kiwifruit orchard with probes for the monitoring of soil water content.

› V International Symposium on Postharvest Pathology

Division Postharvest and Quality Assurance #ishs_dphq

› Group photo of the participants at the University of Liege in the stairs of the academic hall.

The V International Symposium on Postharvest Pathology was held on 19-24 May 2019, in Liège, Belgium, under the aegis of the International Society for Horticultural Sciences (ISHS) and the International Society for Plant Pathology (ISPP). It was the first time that Belgium hosted this prestigious symposium and more precisely thanks to the support of the University of Liège and its Faculty of Agronomy located on the campus Gembloux Agro-Bio Tech.

The previous symposium, held in South Africa in 2017, addressed the next generation innovation and commercial solutions to reduce losses due to postharvest pathology. The present symposium in Liège tackled the postharvest pathology issues from another direction. Indeed, the symposium highlighted the postharvest chain management, and this included the entire process from pathology detection, prevention and protection until processing and distribution to satisfy consumer demands. In this regard, specialists in the field of the plant protection industry and the postharvest technologies were invited to address the problems encountered during this process. They brought a real mirror for problems during the value chain activity (protection products, storage, packaging, distribution). Innovative technologies of detection and protection were also presented.

During the symposium, 132 attendees from 32 countries participated actively in the symposium with 52 oral and 85 poster presentations. The symposium offered the opportunity to exchange advanced technologies, methods, and knowledge towards postharvest disease management of fruits and vegetables. This international symposium was a forum that brought together researchers, academics, and industry professionals to share knowledge and research contributions in the evolving technologies related to postharvest pathology. Ten renowned speakers were invited to cover the eight sessions of the symposium. The symposium opened with two invited presentations: the first was "Postharvest treatments today and in the future: perspectives from the plant protection industry" by Mr. Geoffroy de Chabot-Tramecourt, and the second was "Physiology and pathology: the intersection between postharvest technologies" by Professor Christopher B. Watkins.

The eight sessions were then covered by the following invited speakers:

- SESSION I – Smart innovative technologies for detection of postharvest pathogens and toxic metabolites: Simona Marianna Sanzani: "Smart innovative technologies for detection of postharvest fungal pathogens and their toxic metabolites";
- SESSION II – Innovation in postharvest disease control: Michael Wisniewski: "The next thirty years: envisioning the future of postharvest disease research";
- SESSION III – Elucidation of host pathogen interactions/molecular exploration of host-pathogen interactions: Luis González-Candelas: "From gene expression to the packinghouse: can metal chelation be a possible alternative treatment to control fruit postharvest diseases?";
- SESSION IV – Integrated approaches and new chemistries to reduce postharvest waste: Lluis Palou: "Antifungal edible coatings for postharvest preservation of fresh fruit";

› Prof. Christopher B. Watkins, Chair of ISHS Division Postharvest and Quality Assurance, handing out the ISHS Medal Award to Prof. Haïssam Jijakli, symposium convener.

› Dr. Antonio Ippolito, Department of Soil, Plant and Food Science, University of Bari, Italy, presenting the ISHS Young Minds Awards to A) Núria Baró-Montel for the best oral presentation, B) Marcela Miranda for the best poster.

› Group visit to the bioremediation unit at PCFruit to show how pesticide pollution is managed.

- SESSION V – Alternative postharvest disease control technologies: Neus Teixido: "Alternative means for the management of postharvest pathogens on fruits";
- SESSION VI – Microbiota community in postharvest: Samir Droby: "Engineering the fruit microbiome for biological control of postharvest diseases";
- SESSION VII – Postharvest food safety: Dumitru Macarisin: "Listeria monocytogenes in fresh fruits: the occurrence and potential mechanisms of contamination";
- SESSION VIII – Advances and applied research in handling, packaging, transport, and distribution to reduce postharvest losses: Lise Korsten: "Advances in applied research in handling, packing, transport and distribution to reduce postharvest losses – embracing the 4th industrial revolution".

Besides the science, three social evening events and one guided technical tour strengthened the discussions and future collaborations. The tour visited PCFruit at Sint-Truiden and the Gembloux Agro-Bio Tech, faculty of ULiège.

The ISHS Young Minds Awards were given to Núria Baró-Montel from IRTA, Spain, for the best oral presentation entitled "A walk-through method for identifying brown rot resistance in stone fruit: methodology development, validation, and application on an interspecific almond × peach population", and to Marcela Miranda from the Brazilian Agricultural Research Corporation, EMBRAPA, Brazil, for the best poster entitled "Antifungal activity of *Zingiber officinale* Roscoe (ginger) extracts on postharvest pathogen".

Haïssam Jijakli

› Contact

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› III International Symposium on Growing Media, Composting, and Substrate Analysis

Division Protected Cultivation and Soilless Culture #ishs_dpro
Division Vegetables, Roots and Tubers #ishs_dveg

The III International Symposium on Growing Media, Composting, and Substrate Analysis was held from 24 to 28 June 2019, in Milan, Italy. This symposium was convened by Dr. Patrizia Zaccheo (University of Milan), Dr. Costantino Cattivello (Regional Agency for Rural Development - Friuli Venezia Giulia) and Prof. Dr. Francesco Giuffrida (University of Catania) under the aegis of the ISHS. The symposium gathered 190 participants from 33 countries, who gave 57 oral and 88 poster presentations. The event was divided into nine sessions: Novel components and innovative processing of growing media (GM); Life in GM; Advances in GM characterization; Biochar production and use in GM; Compost production and use in GM; State of the art and future directions of GM industries; Traditional and new cultivation systems; Water and mineral nutrition; and sustainability of GM. During a field day, the participants visited some leading Italian companies in green waste composting and the use of GM and vegetables production and processing.

Over the last decade, soilless cultivation has significantly improved the performances of horticultural systems. This aspect of horticultural production is expected to increase in the future due to the expanding needs of the global population and the scarcity of natural resources. The environmental concerns associated to traditional peat-based growing media have prompted scientists to examine

› Participants of the symposium.

alternative materials. Among these, biomasses derived from forestry and waste streams currently represent the most sustainable option. However, the large-scale adoption of any new growing medium has to pass through a better understanding of its availability, costs, physicochemical and biological modifications during manufacture. The utilization of the medium, its interactions with crops and nutrients, and standardization of methods and terminologies used for its characterization are also key. For these reasons, the goal of this symposium was to provide a scientific update to scientists and industries involved in this area.

Professor Fabrizio Adani from the University of Milano, Italy, presented the opening lecture entitled "Circular economy and nutrient recycling", addressing the problems related to the increasing utilization of fertilizers to sustain food, bioenergy and industrial biomass production. Within this scenario, a pivotal contribution is expected to come from recycling nutrients contained within the agricultural biomasses which, by applying well-consolidated and new technologies, could be used to substitute for synthetic fertilizers. This is promising an agriculture based on a circular economy approach.

The keynote entitled "Microbial life in sustainable and disease suppressive growing media" was presented by Dr. Jane Debode, senior scientist at the Research Institute for Agriculture, Fisheries and Food (ILVO), Belgium. She illustrated the modifications of peat microbiome and the related improved crop performances in strawberry and lettuce soilless cultivation, resulting from the addition of chitin and biochar in the growing medium. Overall, the results highlighted the role these new amendments might play in reducing the environmental impact of horticulture and in contributing to a circular-based economy.

Professor Genhua Niu of the Texas A&M AgriLife Research Center, Texas A&M University at El Paso, USA, presented the keynote entitled "Roles of indoor vertical farming in sustainable production of horticultural crops", which gave a worldwide overview of the status of indoor vertical farming. She underlined that electricity for lighting through LEDs represents the highest operational cost in indoor vertical farming, so it must be used following the most innovative and cost-effective lighting strategies. For this reason, she presented results about the effects of manipulation of light intensity, photoperiod, light spectrum, lighting direction and timing on some vegetable crops cultivable in indoor vertical farms.

During the symposium, the Scientific Committee selected two winners to receive the

› Professor Dr. Stefania De Pascale (left), Chair of ISHS Division Protected Cultivation and Soilless Culture, and Prof. Dr. Youbin Zheng (right), former Chair of ISHS Working Group Composting for Horticultural Applications, presented the ISHS Medal to the Symposium Conveners: Dr. Costantino Cattivello (second from left), Dr. Patrizia Zaccheo (center) and Prof. Dr. Francesco Giuffrida (second from right). The Working Group name has now changed to "Growing Substrates," and the Chair is Prof. Dr. Jean-Charles Michel.

ISHS Young Minds Awards. The awards were presented to Bryan Smith, a PhD candidate of the University of the West Indies, St. Augustine, Trinidad and Tobago, for the best oral presentation entitled "Stability assessment of neem-based compost using chemical, thermogravimetric and spectroscopic analyses", and to Daniel Hauck from the Hochschule Weihenstephan-Triesdorf at Freising, Germany, for the best poster entitled "Plant availability of secondary phosphates depending on pH in a peat based growing medium". Moreover, Italian GM producer associations awarded six Young Mind and two technological transfer money prizes (provided by AIPSA), two compost money prizes (provided by CIC) and two biochar money prizes (provided by ICHAR).

At the end of the symposium, Dr. Jane Debode presented the next International Symposium on Growing Media, Composting, and Substrate Analysis that will be held in Ghent, Belgium, in August 2021.

Rosario Mauro

› Dr. Bill Carlile, former Chair of ISHS Commission Plant Substrates and Soilless Culture (now ISHS Division Protected Cultivation and Soilless Culture), presenting the ISHS Young Minds Awards to A) Bryan Smith for the best oral presentation, B) Daniel Hauck for the best poster.

› Contact

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› II International Symposium on Vegetable Grafting

Division Protected Cultivation and Soilless Culture **#ishs_dpro**
Division Vegetables, Roots and Tubers **#ishs_dveg**

› Participants of the symposium.

The II International Symposium on Vegetable Grafting (ISVG2019) was held in downtown Charlotte, North Carolina, USA, from July 14 to 18, 2019. Members of the United States Department of Agriculture (USDA) Specialty Crop Research Initiative (SCRI) vegetable grafting project team composed the organizing committee. This symposium provided a great opportunity to exchange and discuss science-based information and interpretations for vegetable grafting among academic researchers, extension professionals and industry representatives. In the technical program, we had five invited speaker, 40 oral and 45 poster presentations. Over 135 participants from 18 countries attended the symposium and engaged in discussion. The symposium proceeded using a dynamic interactive format to balance basic and applied vegetable grafting sciences and technologies. "Clusters" of technical presentations during the scientific sessions were followed by moderated discussions aimed at developing con-

› SHS Medal awarded to Conveners Dr. Penelope Perkins-Veazie (left), Dr. Chieri Kubota (center) and Dr. Frank Louws (right).

› From left, Dr. Daniel Leskovar (ISHS representative), Dr. Xin Zhao (Chair of ISHS Working Group Vegetable Grafting) and Dr. Francisco Pérez-Alfocea (former Chair of ISHS Working Group Vegetable Grafting).

sensus-based takeaway messages to outline the best immediate practical applications of the shared research-based information. Presenters, participants, and other contributors addressed a wide range of forward-thinking technical/scientific-, education-, and industry application-related topics specific to vegetable grafting.

Invited speakers provided a wide range of views about scientific status and technologies around vegetable grafting. Professor Francisco Pérez-Alfocea from CEBAS-CSIC, Spain, presented the global perspective of vegetable grafting to address grand challenges. Dr. Rafael Meissner from Rootility, Israel, introduced a commercial sector perspective and the company's effort in breeding innovative rootstocks and applications for processing tomato production in the US. Dr. Roni Cohen from ARO, Israel, shared his wealth of knowledge and wisdom about integrating grafting into sustainable vegetable crop production. Dr. Michitaka Notagaki from Nagoya University, Japan, discussed his very exciting discovery of successful interfamily grafting and biology behind the mechanisms of grafting incompatibility. Dr. Ravishankar Manickam from the World Vegetable Center, Taiwan, completed the invited speaker sessions by presenting the long-term effort of introducing vegetable grafting technologies in developing countries. The technical program was divided into nine oral sessions and two poster sessions. Oral presentation topical areas included: 1) Status of vegetable grafting worldwide, 2) Grafting effects on fruit quality, 3) Transplant production and technology, 4) Vegetable grafting for various production systems, 5) Soilborne disease management by grafting, 6) Rootstock and scion interaction, and 7) Addressing abiotic and biotic factors.

As a unique and effective mechanism for information exchange, a 20-minute discussion mini session (called extension summation) was integrated into this symposium following each oral session to actively engage participants in exploring relevant applications of the research-based information presented. Extension summations were a guided Q/A with discussion between presenters and audience, based on the preceding technical presentations, and helped to identify limitations in application by stakeholders and future priorities for investigation. Another approach we employed in this symposium was flash talks by poster session presenters, where each poster presenter could introduce and promote their posters within a 60-second, strictly timed talk. The extension summations and flash talks promoted and highly engaged valuable networking and interaction among participants.

The ISHS Young Minds Awards were presented to Marlee Trandel from North Carolina State University, USA, for the best oral presentation entitled "Grafting watermelon onto interspecific hybrid squash combats hollow heart disorder", and to Tian Gong from the University of Florida, USA, for the best poster entitled "Exploring chamberless healing for small-scale production of grafted tomato transplants". The second place awardees were Brandon Huber from North Carolina State University, USA (oral presentation), and Tricia Jenkins from Kansas State University, USA (poster).

› From left to right: Francisco Perez-Alfocea (former Chair ISHS Working Group Vegetable Grafting), Daniel Leskovar (ISHS representative), Erin Rosskopf (Chair of the ISHS Young Minds Award Committee), Chieri Kubota, Penelope Perkins-Veazie and Frank Louws (Conveners) presenting the ISHS Young Minds Award to A) Marlee Trandel for the best oral presentation, B) Tian Gong for the best poster.

The full-day post-symposium tour was held on the final day following the 3-day scientific program. Tour buses left the symposium venue early morning and visited several commercial operations and organizations in North Carolina, including two vegetable grafting nurseries (Tri-Hishtil and Banner Greenhouses), a vegetable producer/packer (Flavor 1st Growers & Packers), and a regional research and extension center (NC State Mountain Crops Research and Extension Center).

At the business meeting of ISHS Working Group Vegetable Grafting, organized by the working group chair Dr. Francisco Pérez-Alfocea and ISHS representative Dr. Daniel Leskovar, Dr. Xin Zhao from the University of Florida was selected as the new working group chair. Dr. Zhao is also leading the publication of *Acta Horticulturae* from this symposium. The III International Symposium on Vegetable Grafting will be held in Spain in 2023 with Dr. Francisco Pérez-Alfocea as Convener.

Finally, on behalf of ISVG2019 organizing committee, we would like to thank all our sponsors, exhibitors, local and international leaders, scientific committees who share the vision of "making a difference" by investing time, experience and resources. There is a deep satisfaction in an engaged international group of people who can come together to organize, share and advance opportunities on a daily basis and through international symposia. We also acknowledge the United States Department of Agriculture - Specialty Crop Research Initiative grant program (2016-51181-25404) for supporting this symposium.

Frank Louws, Chieri Kubota, Penelope Perkins-Veazie, Xin Zhao and Wendy Britton

› Demonstration of machine-assisted grafting at a nursery in North Carolina, during the post-symposium tour.

› Contact

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› First International Symposium on Precision Management of Orchards and Vineyards

Division Temperate Tree Nuts **#ishs_dnut**

The first International Symposium on Precision Management of Orchards and Vineyards was successfully held on 7-11 October 2019, in Palermo, Sicily (Italy). The symposium was organized by the Department of Agricultural, Food and Forest Sciences, at the University of Palermo under the auspices of the International Society for Horticultural Science (ISHS) and with the support of the Italian Society for Horticultural Science (SOI). The symposium benefited from the contribution, monetary or in the form of goods, of 15 sponsors: nine companies involved in the development of precision tools and machinery used in agriculture (Martignani, Centroamar s.r.l., AgriBioClay, GoldenGrapes, Pernice, Gregoire, Volentieri Pellenc, Maniscalco and SAME) and six wineries located in western Sicily (Donnafugata, Feudo Arancio, Tenuta Rapitalà, Rapinzeri, Mandrarossa and Tenute Orestiadi).

The symposium attracted about 115 participants from 24 countries (Australia, Belgium, Brazil, Canada, Chile, Czech Republic, China, France, Germany, Hungary, India, Israel, Italy, Japan, Korea, New Zealand, Portugal, Russia, South Africa, Spain, Sweden, Switzerland, UK and USA), a good confirmation of the broad interest for the scientific and technical aspects of precision management, and a successful exchange between orchard and vineyard experts.

The symposium consisted of seven sessions: 1) Irrigation and water relations (chaired by Luca Corelli Grappadelli from University of Bologna and Gerardo Lopez from iTK), 2) Yield and harvest monitoring (chaired by James Taylor from Irstea), 3) Mapping and decision support platforms/systems (chaired by Carlos Lopes from University of Lisbon), 4) Canopy growth and management (chaired by Gregory Lang from University of Michigan and Alessandro Matese from IBIMET - CNR), 5) Disease and pest pressure detection/control (chaired by Dany Bylemans from Pcfruit – University of Leuven), 6) Fruit growth, ripening, quality and postharvest (chaired by Richard Bastias from University of Concepción), and 7) Soil management, fertility, and nutrition (chaired by Matteo Gatti from Catholic University of Piacenza). The program listed four invited and 48 oral presentations and 44 posters. Four days were devoted to scientific sessions and one day to a technical excursion to a vineyard and winery, an olive mill and an olive orchard in three different locations of south-western Sicily. The five days of activities were followed by a one-day post-symposium tour to the ancient Elimian locations of Segesta and Erice separated by a lunch break at the Pellegrino winery near the salt ponds of Marsala.

During coffee breaks, fruit, sweets and savoury sandwiches typical of the Sicilian tradition were offered to all registered par-

› Participants of the symposium at the opening ceremony.

› Prof. Tiziano Caruso (left), Chair of ISHS Division Temperate Tree Nuts, handing over the ISHS medal award to Conveners Luigi Manfrini (A), Riccardo Lo Bianco (B) and Antonino Pisciotta (C).

ticipants. During lunches, a variety of fish, meat and vegetable-based dishes typical of the Sicilian tradition were served along with a selection of fine white and red wines from the Sicilian wineries sponsoring the event.

The opening ceremony started with a brief welcome address by Convener Prof. Riccardo Lo Bianco (University of Palermo), in which he introduced the Co-Conveners of the symposium, Dr. Antonino Pisciotta (University of Palermo) and Dr. Luigi Manfrini (University of Bologna), and extended his thanks and gratitude to the participants and the members of the Scientific and Organizing Committees. Afterwards, Prof. Stefano Colazza, head of the Department of Agricultural, Food and Forest Sciences, exposed his welcome address to the University of Palermo and specifically to the department facilities hosting the event. Subsequently, Prof. Tiziano Caruso, Chair of ISHS Division Temperate Tree Nuts, presented information about ISHS activities, while Prof. Paolo Inglese, delegate of the Italian Society for Horticultural Science (SOI), presented information about SOI activities and renewed the support by SOI to the symposium. Finally, Prof. Michele Pisante from the University of Teramo gave an introductory speech on "Precision agriculture in Italy: perspectives and barriers".

During the four days of scientific sessions, mornings were entirely dedicated to oral presentations, whereas afternoons were dedicated to poster presentations. On 8 October, Dr. James Taylor from Irstea (France) gave an invited speech on "The role of zoning and data fusion in precision horticulture: a review of current and needed capabilities to assist decision-making". Dr. Taylor recalled the progress made by zoning and data fusion during the past 10-15 years and underlined the great potential of both procedures for the horticulture and viticulture industries in the next decade. On the same day, during some space dedicated to companies, Andrea Lonardi from Bertani Domains presented material on "Practical applications of precision farming in viticulture". On 10 October, Dr. Ken Breen from the New Zealand Institute for Plant & Food Research Ltd gave an invited speech on "Physiologically-based precision orchard management facilitates increased yields of premium quality fruit". During the symposium several important aspects of precision water, nutrient, canopy, crop load, fruit quality, soil and pest management were discussed. On several occasions, during the scientific sessions, during the technical tour or simply during coffee and lunch breaks, the opportunity to exchange research and information between orchard and viticulture experts was underlined and greatly appreciated.

At the end of the second day, a business meeting was held, led by Riccardo Lo Bianco and Tiziano Caruso, where three candidatures for the next venue of the symposium where presented: 1) Luca Brillante proposed California State University (Fresno) and UC Davis, USA; 2) Mark O'Connell proposed Agriculture Victoria, Tatura and Mildura, Australia; 3) Pilar Barreiro Elorza (absent) proposed Escuela Técnica Superior de Ingeniería Agronómica, Alimentaria y de Biosistemas (ETSIAAB), Universidad Politécnica de Madrid, Spain. After voting, Agriculture Victoria, Tatura and Mildura, Australia was elected the venue for the next International Symposium on Precision Management of Orchards and Vineyards in 2023. At the end of the meeting, Prof. Caruso handed the ISHS medals to the Conveners.

The gala dinner was held in the marvelous settings of baroque Palazzo Fatta, in the heart of downtown Palermo, where participants enjoyed a rich variety of the Mediterranean flavors from the Sicilian cuisine.

Wednesday, 9 October, was entirely dedicated to field excursions to the area between Menfi and Sciacca. Participants visited first the vineyards and winery of Feudo Arancio where owners and researchers of the

› Conveners Luigi Manfrini, Antonino Pisciotta and Riccardo Lo Bianco, and Carlos Lopes, member of the committee to evaluate the oral and poster presentations, presenting the ISHS Young Minds Award certificates to Gianmarco Bortolotti (right) for the best oral presentation and to Sydney Kaplan (left) for the best poster.

› Field excursion to Menfi and Sciacca. A) Visit to winery of Feudo Arancio. B) Continuous olive harvester at work.

University of Palermo gave demonstrations with a precision sprayer using ionized mist and aerial image acquisition and monitoring using a drone. The visit of the company continued with a guided tour of the cellar and a wine tasting. On the way to the olive mill, the group stopped at a nearby field to watch a brief demonstration of a GPS-driven own-rooted olive transplanter. Once at the olive mill, participants were able to follow the entire olive oil extraction process including a precision image sorter separating olives by size and color to obtain desired types of olive oil based on degree of fruit ripeness. At the end of olive oil extraction, a cooking demonstration based on olive oil recipes was given and participants enjoyed plenty of traditional Sicilian dishes made with freshly squeezed olive oil. The group finally moved to an intensive olive orchard in the area to see an example of a modern training system and a continuous olive harvester at work.

At the beginning of the symposium, the conveners appointed a committee composed of Antonino Pisciotta, Carlos Lopes, Gregory Lang and Ken Breen to evaluate oral presentations and posters presented by junior scientists participating in the ISHS Young Minds Award. On Friday 11 October in the afternoon, Prof. Riccardo Lo Bianco presented the ISHS Young Minds Awards to Dr. Gianmarco Bortolotti from the University of Bologna, Italy, for the best oral presentation entitled "Application of organic photo-voltaic films on fruit trees: a proof of concept for a self-sustainable orchard" and to Sydney Kaplan from the Illinois Institute of Technology, USA, for the best poster entitled "Creating a multi-purpose unmanned aerial vehicle-based platform for sampling, monitoring and measuring the fruiting tree canopy".

All participants agreed that the scientific sessions, tours, and cultural events were a great success and that the exchange of information, reinforcement of established collaborations, and creation of new friendships will have a positive impact on science and industry related to precision management of orchards and vineyards.

Riccardo Lo Bianco

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› VI International Symposium on Cucurbits

Division Vegetables, Roots, and Tubers #ishs_dveg

The VI International Symposium on Cucurbits was held in Ghent, Belgium, from 30 June to 4 July 2019. Flanders, the northern region of Belgium, is known for its vegetable production with a cultivated area of 1,111 ha in greenhouses and 48,914 ha open field production in 2018. Tomato is the main greenhouse crop, but ±65-70 ha are dedicated to cucumber production, which is mainly an all-year-round soilless production system, although 7 ha alternate with lettuce. Zucchini is produced both under protection (soilless or soil-bound) and in open field and on ±700 ha. Open field pumpkin production accounts for ±400 ha.

The International Symposium on Cucurbits was first held in 1997, in Turkey, and since then about every four years. Japan, Australia, China and Spain have been the hosts, and now the sixth in the series occurred in Ghent, Belgium. It was co-organised by Ghent University, Inagro, and the Research Station for Vegetable Production, and brought together 123 participants from 27 countries. During three days, six keynotes and 34 orals were presented. In addition, 43 posters were placed in two poster sessions. The oral and poster presentations were grouped into eight sessions: genetic resources and breeding technologies; protected cultivation; mycology; virology and bacteriology; fruit quality; propagation and grafting; nutritional content and health benefits; and biostimulants and abiotic stress.

In session 1, different topics were brought ranging from origin and diversity of *Cucurbita pepo* and *C. moschata,* current breeding goals of the World Vegetable Centre with a focus on bitter gourd and tropical pumpkin, and molecular tools to be used in breeding programs. Session 2 focused on greenhouse production systems. This session was introduced by Dr. Vänninen (Natural Resource Institute, Finland) who brought critical notes to current glasshouse production and the need for constant innovation. Worldwide cucurbit production is threatened by several diseases and viruses (sessions 3 and 4). Dr. Grumet (Michigan State University, USA) introduced the USDA-SCRI 'CucCap' project that has developed genomic tools for the *Cucurbitaceae* to facilitate introgression and stacking of disease resistance loci. She also described her research to identify young fruit

and age-related resistance to *Phytophthora* fruit rot of cucumber. In 2019, at least 92 virus species in 28 genera were described. Dr. Desbiez (INRA, France) reviewed these rapidly increasing numbers of viruses infecting cucurbits as well as their geographic distribution based on long-term surveys and population genetic approaches. She also summarized the best management strategies. Session 5, on fruit quality, was introduced by Dr. Tadmor (ARO, Israel) who talked about the genetic mechanism underlying the quantity of carotenoids accumulating in melon fruit flesh and the role of a specific gene called the 'golden SNP'. This knowledge opens possibilities for carotenoid biofortification. In session 6 on propagation and grafting, Dr. Picó Sirvent (University of Valencia, Spain) gave a comprehensive overview of the role of rootstocks (both *Citrullus* and *Cucumis* spp.) in melon production to overcome both soilborne diseases and abiotic stress factors such as drought and salt stress. Their impact on productivity and fruit quality parameters under standard and organic farming production were also presented. In session 7, Dr. Patil (Texas A&M University, USA) talked about the various health-promoting compounds present in cucurbits and about the methodology to identify these compounds. He illustrated the health benefits with case studies of melons and brain health, watermelon and heart and prostate health and bitter gourd and diabetes. In session 8, Dr.

› Participants of the symposium.

Colla (University of Tuscia, Italy) reviewed the different groups of biostimulants and illustrated resilience to abiotic stresses in cucurbit crops by several case studies on how the application of non-microbial as well as microbial plant biostimulants could increase yield, nutrient efficiency, abiotic stress tolerance and modulate the nutritional and functional quality of cucurbits.

The ISHS Young Minds Awards were given to Jeroen Berg, Wageningen University, The Netherlands, for the best oral presentation entitled "Identification of candidate genes for quantitative downy mildew resistance in cucumber", and to Raquel Jiménez Muñoz, University of Granada, Spain, for the best poster entitled "Implementation of an *Agrobacterium*-mediated transformation and regeneration protocol in *Cucurbita pepo* (zucchini)".

One full day was dedicated to field visits related to research, production and processing. Two technical tours brought the participants to the vegetable auctions Reo and BelOrta, cucurbit research at Inagro and PSKW (Research Station for Vegetable Production), a high wire cucumber production installed with 180 µmol m^{-2} s^{-1} SON-T supplementary lighting (Eric and Lander Van Den Eynde), a low-wire cucumber production with a fully robotised packing process, open field productions of zucchini (Jasper Haghedooren) and a fresh-frozen vegetables processing factory (Ardo).

At the ISHS business meeting, Prof. Xingfang Gu from the Chinese Academy of Agricultural Sciences was elected as new Chair of ISHS Working Group *Cucurbitaceae*. The next International Symposium on Cucurbits will be held in 2023 in Zhengzou, China, with Dr. Liu Wenge as convener.

Marie-Christine Van Labeke

› Contact

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› Daniel Leskovar (second from right), Chair of ISHS Division Vegetables, Roots and Tubers, Marisa Guillamon (right), former Chair of ISHS Working Group *Cucurbitaceae*, and Symposium Conveners, Raf De Vis (left), Marie-Christine Van Labeke (second from left) and Peter Bleyaert (third from left), presenting the ISHS Young Minds Awards to Jeroen Berg (center) for the best oral presentation and to Raquel Jiménez Muñoz (third from right) for the best poster.

› Field excursion to A) the low-wire production of cucumber, B) a zucchini production field.

From the Secretariat

› New ISHS members

ISHS is pleased to welcome the following new members:

New Individual Members

Argentina: Mr. German Babelis, Prof. Alfredo Olguín Pringles, Prof. Daniela Pacheco, Prof. Dr. Sonia Sgroppo; **Australia:** Dr. Subhashini Abeysinghe, Mr. Abdulaziz Almesbah, Terry Benning, Mr. Massimo Bianco, Ms. Yiru Chen, Mr. Alexander Laurie, Mr. Jonathan Lidbetter, Mr. Alexander Mackenzie, Dr. Stephen Morris, Vince Neil, Ms. Madeleine Peavey, Dr. Kristen Stirling; **Belarus:** Georgy Chernov; **Belgium:** Ms. Caroline De Meyer, Ms. Manju Joseph, Ms. Lijuan Meng, Mr. Shusheng Wang; **Brazil:** Isabela Hernandes, Prof. Dr. Nadson Pontes; **Bulgaria:** Assoc. Prof. Hristo Dzhugalov, Assist. Prof. Nesho Neshev; **Canada:** Ms. Vera Amo Larbi, Mr. Jean Lafond, Dr. Debra Moreau, Dr. Hao Xu; **Chile:** Assoc. Prof. Jaime Guerrero, Dr. Set Perez Fuentealba; **China:** Fei Cai, Dr. Tong Chen, Zhuo Cheng, Prof. Dr. Huimei Cui, Assoc. Prof. Jinxia Cui, Dr. Xingguang Dong, Prof. Dr. Jianrong Feng, Assist. 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› Calendar of ISHS events

For updates and extra information go to www.ishs.org and check out the calendar of events. Alternatively use the "science" option from the website navigation menu for a comprehensive list of meetings for each Division or Working Group.
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Year 2020

- March 15-19, 2020, San Juan (Argentina): **XVI International Symposium on Processing Tomato - XIV World Processing Tomato Congress.** Info: Dr. Luca Sandei, SSICA, Tomato Department, Viale f.Tanara 31/a, 43121 Parma (PR), Italy. Phone: (39) 0521795257, Fax: (39) 0521771829, E-mail: luca.sandei@ssica.it or Dr. Cosme A. Argerich, Instit. Nac. de Tecnol. Agro., C.C. Nro. 8, La Consulta, 5567 Mendoza, Argentina. Phone: (54)2622470304, Fax: (54)2622470753, E-mail: argerich.cosme@inta.gob.ar or Ms. Sophie Colvine, AMITOM, 1328 route de Loriol, 84170 Monteux, France. E-mail: symposium@worldtomatocongress.com E-mail symposium: symposium@worldtomatocongress.com Web: http://www.worldtomatocongress.com
- March 24-29, 2020, Brena Baja (La Palma) & La Laguna (Tenerife) (Spain): **XIV International Protea Research Symposium.** Info: Dr. Juan Alberto Rodríguez Pérez, Àrea de Producción Vegetal, Universidad de La Laguna, Calle Dinamarca 29, 38300 La Orotava Tenerife, Spain. Phone: (34)666695267, E-mail: jarodrip@ull.es Web: https://proteas2020.asocan.net

NEW

- April 22-26, 2020, Uvero Alto, La Altagracia (Dominican Republic): **X International Pineapple Symposium.** Info: Mr. Joelin Santos, AsoproPimopla, C/ Altagracia 100, Monte Plata, Dominican Republic. Phone: (829)745-0318, E-mail: j.santos@asopropimopla.org E-mail symposium: xpineapple2020@gmail.com Web: http://www.cedaf.org.do/eventos/xpineapple2020/
- May 2-6, 2020, Rimini (Italy): **IX International Strawberry Symposium.** Info: Prof. Dr. Bruno Mezzetti, Dip.Sci. Agrarie, Alimentari ed Ambientali, Università Politecnica delle Marche, Via Brecce Bianche, Ancona 60100, Italy. Phone: (39)0712204933, Fax: (39)0712204856, E-mail: b.mezzetti@univpm.it or Prof. Dr. Maurizio Battino, Dept of Clinical Sciences, Sect Biochemistry, Università Politecnica delle Marche, Via Ranieri, 65 - 60100 Ancona, Italy. E-mail: m.a.battino@univpm.it or Dr. Gianluca Baruzzi, Council for Agric. Research & Economics, via La Canapona, 1 bis, Magliano, 47100 Forlì, Italy. Phone: (39) 543 89566, Fax: (39) 543 89077, E-mail: gianluca.baruzzi@crea.gov.it Web: https://www.iss2020.com/

NEW

- May 7-9, 2020, Bangkok (Thailand): **III Asian Horticultural Congress - AHC2020.** Info: Mr. Ananta Dalodom, Horticultural Science Society Thailand, Department of Agriculture, 50 Paholyothin Rd., Chatuchak, Bangkok 10900, Thailand. Phone: (66)29406578, Fax: (66)29406579, E-mail: ananta.dalodom@gmail.com or Ms. Peyanoot Naka, Horticulture Research Institute, Department of Agriculture, Chatuchak, Bangkok 10900, Thailand. Phone: (66)819076821, Fax: (66)25614667, E-mail: peyanoot.naka@gmail.com or Yaowalak Phuangkumchoo, VNU Exhibitions Asia Pacific Co., Ltd., Bangkok 10120, Thailand. E-mail: yaowalak.phu@vnuexhibitionsap.com E-mail symposium: ahc2020bangkok@gmail.com Web: http://ahc2020.org/

NEW

- May 17-20, 2020, Leuven (Belgium): **XIII International Controlled and Modified Atmosphere Research Conference - CaMa2020.** Info: Prof. Bart Nicolai, Flanders Centre for, Postharvest Technology, W. De Croylaan 42, 3001 Heverlee, Belgium. Phone: (32)16322375, Fax: (32)16322955, E-mail: bart.nicolai@biw.kuleuven.be or Dr. Maarten Hertog, BIOSYST-MeBioS, K.U. Leuven, de Croylaan 42 - bus 2428, B-3001 Heverlee, Belgium. Phone: (32)16322376, Fax: (32)16322955, E-mail: maarten.hertog@kuleuven.be Web: https://cama2020.org/
- May 20-22, 2020, Torino (Italy): **IV International Symposium on Woody Ornamentals of the Temperate Zone.** Info: Prof. Dr. Valentina Scariot, Università degli Studi di Torino, Dept. Agric., Forestry & Food Sci., Largo Paolo Braccini 2, 10095 Grugliasco, Torino, Italy. Phone: (39)0116708932, Fax: (39)0116708798, E-mail: valentina.scariot@unito.it or Prof. Dr. Gabriele Loris Beccaro, Università degli Studi di Torino, Dept. Agric., Forestry & Food Sci., Largo Paolo Braccini 2, 10095 Grugliasco, Torino, Italy. Phone: (39)0116708802, Fax: (39)116708658, E-mail: gabriele.beccaro@unito.it E-mail symposium: woodyornamentals2020@unito.it Web: https://www.woodyornamentals2020.com/

NEW

- June 2-6, 2020, Stuttgart (Germany): **IV International Symposium on Horticulture in Europe - SHE2020.** Info: Prof. Dr. Jens N. Wünsche, University of Hohenheim, Department of Crop Science, Section Crop Physiology of Specialty Crops, Emil-Wolff-Str. 25, 70593 Stuttgart, Germany. Phone: (49)711-459-22368, Fax: (49)711-459-22351, E-mail: jnwuensche@uni-hohenheim.de or Dr. Michael Helmut Hagemann, University of Hohenheim, Department of Crop Science, Section Crop Physiology of Specialty Crops, Emil-Wolff-Str. 25, 70599 Stuttgart, Germany. or Ms. Eva Gautsch, Interplan AG, Landsberger Str. 155, Munich, Germany. E-mail: e.gautsch@interplan.de Web: https://she-ihs-fav2020.de/

NEW

- June 2-6, 2020, Stuttgart (Germany): **VIII International Symposium on Human Health Effects of Fruits and Vegetables - FAVHEALTH2020.** Info: Prof. Dr. Jens N. Wünsche, University of Hohenheim, Department of Crop Science, Section Crop Physiology of Specialty Crops, Emil-Wolff-Str. 25, 70593 Stuttgart, Germany. Phone: (49)711-459-22368, Fax: (49)711-459-22351, E-mail: jnwuensche@uni-hohenheim.de or Prof. Dr. Bhimanagouda Patil, VFIC, Texas A&M University, Department of Horticulture, 1500 Research Parkway Ste A120, College Station, TX 77845, United States of America. Phone: (1)9794588090, Fax: (1)9798624522, E-mail: b-patil@tamu.edu or Ms. Eva Gautsch, Interplan AG, Landsberger Str. 155, Munich, Germany. E-mail: e.gautsch@interplan.de Web: https://she-ihs-fav2020.de/

NEW

- June 2-5, 2020, Stuttgart (Germany): **V International Humulus Symposium.** Info: Prof. Dr. Jens N. Wünsche, University of Hohenheim, Department of Crop Science, Section Crop Physiology of Specialty Crops, Emil-Wolff-Str. 25, 70593 Stuttgart, Germany. Phone: (49)711-459-22368, Fax: (49)711-459-22351, E-mail: jnwuensche@uni-hohenheim.de or Dr. Michael Helmut Hagemann, University of Hohenheim, Department of Crop Science, Section Crop Physiology of Specialty Crops, Emil-Wolff-Str. 25, 70599 Stuttgart, Germany. or Ms. Eva Gautsch, Interplan AG, Landsberger Str. 155, Munich, Germany. E-mail: e.gautsch@interplan.de Web: https://she-ihs-fav2020.de/

NEW

- June 7-11, 2020, Moscow (Russian Federation): **XV International Symposium on Virus Diseases of Ornamental Plants.** Info: Dr. Tatiana Mitiouchkina, Branch of Institute of Bioorganic

Chemistry, Science av.6, 142290 Moscow region Pushchino, Russian Federation. Phone: (7)4967731779, Fax: (7)4967731779, E-mail: tatiana@planta.bio Web: http://isvdop2020.vniisb.ru/

- June 7-11, 2020, Ma'ale HaHamish (Israel): **IX International Symposium on Mineral Nutrition of Fruit Crops.** Info: Dr. Uri Yermiyahu, Gilat Research Center, Soil and Water, Mobile Post Negev 85280, Israel. Phone: (972)89928649, Fax: (972)79926485, E-mail: uri4@agri.gov.il or Dr. Arnon Dag, Plant Sciences, Gilat Research Center, Agricultural Research Organization, (The Volcani Center), Mobile Post Negev, 85280, Israel. Phone: (972)506220155, Fax: (972)89926485, E-mail: arnondag@agri.gov.il Web: https://www.ortra.com/events/mnutrition2020
- June 8-12, 2020, Malmö (Sweden): **IX International Symposium on Light in Horticulture.** Info: Assist. Prof. Most Tahera Naznin, Department of Biosystems and Technology, Swedish University of Agricultural Sciences, Box 103, 23053 Alnarp, Sweden. Phone: (46)40415019, E-mail: naznin.most.tahera@slu.se or Dr. Maria Karlsson, Växtskyddsvägen 3, skne, Hunnestorpsvägen 29, skne, 23053 BstadAlnarp, Sweden. Phone: (46)40-415370, E-mail: maria.e.karlsson@slu.se or Prof. Dr. Beatrix Waechter Alsanius, Dept. of Biosystems and Technology, SLU, Box 103, 230 53 Alnarp, Sweden. Phone: (46)40415336, E-mail: beatrix.alsanius@slu.se or Dr. Karl-Johan I. Bergstrand, SLU, Department of Horticulture, Box 103, 230 53 Alnarp, Sweden. Phone: (46)040415343, E-mail: karl-johan.bergstrand@slu.se E-mail symposium: ISHSLight2020@slu.se Web: https://www.ishslight2020.se/
- June 21-26, 2020, Coimbra (Portugal): **VIII International Symposium on Production and Establishment of Micropropagated Plants.** Info: Prof. Dr. Jorge Canhoto, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra, Portugal. Phone: (351)239855210, Fax: (351)239855211, E-mail: jorgecan@ci.uc.pt or Dr. Sandra Correia, Department of Life Sciences, University of Coimbra, Calcada Martim de Freitas, 3000-456 Coimbra, Portugal. Phone: (351)239240700, Fax: (351)239240701, E-mail: sandraimc@ci.uc.pt E-mail symposium: pempishs.coimbra2020@uc.pt
- July 7-10, 2020, Zlatibor (Serbia): **XII International Symposium on Plum and Prune Genetics, Breeding and Pomology.** Info: Dr. Darko Jevremovic, Kralja Petra I 9, 32000 Cacak, Serbia. Phone: (381)32321375, Fax: (381)32321391, E-mail: darkoj@ftn.kg.ac.rs E-mail symposium: plum2020@institut-cacak.org Web: http://www.plum2020.com
- July 22-24, 2020, Bogor, West Java (Indonesia): **II International Symposium on Tropical and Subtropical Ornamentals.** Info: Dr. Syarifah Iis Aisyah, Dept.of Agronomy and Horticulture, IPB, Jl. Meranti, Kampus IPB Darmaga, 16680 West Java Bogor, Indonesia. Phone: (62)2518629353, E-mail: syarifahiis@yahoo.com or Dr. Dewi Sukma, Department of Agronomy and Horticulture, Bogor Agricultural University, Jl. Meranti Kampus IPB Dramaga, 16680 Bogor, Indonesia. Phone: (62)-251-8629353, Fax: (62)-251-8629353, E-mail: dsukma70@yahoo.com E-mail symposium: tso2020indonesia@gmail.com Web: http://tso2020.ipb.ac.id
- July 26-31, 2020, Wenatchee, WA (United States of America): **XII International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems.** Info: Prof. Stefano Musacchi, Washington State University, TFREC, 1100 N. Western Ave., Wenatchee, WA 98801-1230, United States of America. Phone: (1)509-663-8181, Fax: (1)509-662-8714, E-mail: stefano.musacchi@wsu.edu E-mail symposium: info@2020orchardsystems.comWeb:https://2020orchardsystems.com/

NEW

- August 25-28, 2020, Bangalore (India): **International Symposium on Tropical and Subtropical Viticulture.** Info: Prof. Dr. Dilipraj Patil, Associate director of Research, MHREC, University of Horticultural Sciences, Udyanagiri, Bagalkot, 587104, India. E-mail: adrebagalkot@uhsbagalkot.edu.in or Dr. Girigowda Manjunatha, Officer In-charge, Bio-control laboratories, Directorate of Horticulture, University of Horticultural sciences, Bagal, Karnataka, 570020, India. Phone: (91)9916219697, E-mail: gmanjunath2007@gmail.com Web: http://iststvbagalkot2020.com/
- August 30 - September 3, 2020, Halifax, Nova Scotia and Charlottetown, Prince Edward Island (Canada): **XII International Vaccinium Symposium.** Info: Prof. Dr. David Percival, Dalhousie University, Department of Plant, Food, and Environmental Sciences, PO Box 550, Truro, NS B2N 5E3, Canada. Phone: (1)9028937852, Fax: (1)9028931404, E-mail: david.percival@dal.ca Web: http://www.Dal.ca/ivs

NEW

- September 7-10, 2020, Palermo (Italy): **International Symposium on Tropical and Subtropical Horticulture in Mediterranean Climate.** Info: Prof. Vittorio Farina, Università degli Studi di Palermo, Dipartimento Scienze Agrarie, Alimentari e Forestali, viale delle Scienze edif 4 - 90128 Palermo, Italy. Phone: (+39)09123896090, E-mail: vittorio.farina@unipa.it or Dr. Giuseppe Sortino, Department of Agricultural & Forest Science, University of Palermo, Viale delle Scienze, Edificio 4 ingresso H, 90128 Palermo, Italy. Phone: (39)09123861234, E-mail: giuseppe.sortino@unipa.it E-mail symposium: info@tropmed2020.it Web: http://www.tropmed2020.it
- September 21-24, 2020, Palermo (Italy): **II International Symposium on the Role of Plant Genetic Resources in Reclaiming Lands and Environment Deteriorated by Human and Natural Actions.** Info: Prof. Francesco Marra, Department of Agricultural & Forest Science, Viale delle Scienze, Edificio 4 ingresso H, 90128 Palermo, Italy. Phone: (39)09123861236, Fax: (39)09123861211, E-mail: francescopaolo.marra@unipa.it or Dr. Emilio Badalamenti, Viale delle Scienze, Palermo, Italy. E-mail: emilio.badalamenti@unipa.it E-mail symposium: info@ispgr-it2020.it Web: http://www.ispgr-it2020.it
- September 24-26, 2020, Ohrid (North Macedonia): **VIII South-Eastern Europe Symposium on Vegetables and Potatoes.** Info: Prof. Dr. Gordana Popsimonova, Debarca 16, 1000 Skopje, North Macedonia. Phone: (389)70255878, E-mail: gpopsimonova@yahoo.com or Skender Kaciu, Univ. of Prishtina-Faculty of Agri., and Veterinary, Boulevar B.Clinton bb, 10000 Prishtina, Kosovo. E-mail: skenderkaciu@yahoo.com E-mail symposium: contact@ishs8.org Web: https://ishs8.org/
- September 28-30, 2020, Bari (Italy): **I International Symposium on Plant Propagation, Nursery Organization and Management for the Production of Certified Fruit Trees.** Info: Prof. Salvatore Camposeo, Università di Bari, Dipt. di Scienze Agro-Ambientali e Territor, Via Amendola 165/a, 70126 Bari, Italy. Phone: (39)0805442982, Fax: (39)0805442982, E-mail: salvatore.camposeo@uniba.it or Prof. Dr. Tiziano Caruso, Department of Agricultural & Forest Science, University of Palermo, Viale delle Scienze, Edificio 4 ingresso H, 90128 Palermo, Italy. Phone: (39) 09123861207, E-mail: tiziano.caruso@unipa.it or Prof. Vito Nicola Savino, University of Bari - Microbiologia Applic., Dip. Protezione delle Piante, Via Amendola 165a, 70126 Bari, Italy. Phone: (39)0805443069, Fax: (39)0805443608, E-mail: vitonicola.savino@uniba.it E-mail symposium: info@certfruit2020.org Web: http://www.certfruit2020.org
- October 5-8, 2020, Catania (Italy): **III International Organic Fruit Symposium and I International Organic Vegetable Symposium.** Info: Prof. Dr. Ferdinando Branca, Di3A, Università di Catania, Via Valdisavoia 5, 95123 Catania, Italy. Phone: (39)095234307, Fax: (39)095234329, E-mail: fbranca@unict.it or Dr. Alberto Continella, University of Catania, Via Valdisavoia 5, Catania, Italy. Phone: (39)095-234455, Fax: (39)095-234406, E-mail: acontine@unict.it or Dr. Alessandro Tribulato, via Valdisavoia, 5, 95123 Catania,

Italy. Phone: (39) 095 234328, Fax: (39) 095 234329, E-mail: atribula@unict.it E-mail symposium: info@orghort2020.it Web: https://www.orghort2020.it/

- October 6-9, 2020, Yalova (Turkey): **X International Symposium on Kiwifruit.** Info: Dr. Arif Atak, Horticultural Central Research Institute, Yalova, Turkey. Phone: (90)2268142520, Fax: (90)2268141146, E-mail: atakarif@gmail.com E-mail symposium: secretariat@kiwi2020.org Web: http://www.kiwifruit2020.org/
- October 11-15, 2020, Nara (Japan): **VII International Symposium on Persimmon.** Info: Prof. Dr. Keizo Yonemori, Faculty of Agriculture, Ryukoku University, 1-5 Yokotani, Seta Oe-cho, Otsu 520-2194, Siga, Japan. Phone: (81)775995695, Fax: (81)775995608, E-mail: keizo@agr.ryukoku.ac.jp E-mail symposium: 2020persimmon@gmail.com Web: http://kaki2020.jshs.jp

NEW

- October 11-15, 2020, Stellenbosch (South Africa): **XI International Symposium on Grapevine Physiology and Biotechnology.** Info: Melané Vivier, Institute for Wine Biotechnology, Department of Viticulture and Oenology, Private Bag x1, Matieland, 7602, South Africa. Phone: (27)218083773, Fax: (27)218083771, E-mail: mav@sun.ac.za or Johan Burger, Stellenbosch University, Department of Genetics, Private Bag X1, Matieland, 7002 Stellenbosch, South Africa. E-mail: jtb@sun.ac.za Web: http://www.isgpb2020.com

NEW

- October 14-17, 2020, Nanjing (China): **V International Symposium on Biotechnology and Molecular Breeding in Horticultural Species.** Info: Jun Wu, Nanjing Agricultural University, College of Horticulture, Nanjing, Jiangsu, 210095, China. E-mail: wujun@njau.edu.cn or Prof. Dr. Shaoling Zhang, Nanjing Agricultural University, 1 Weigang, 210095 Nanjing, China. E-mail: nnzsl@njau.edu.cn Web: http://www.bmbh2020.org

NEW

- October 15-17, 2020, Kansas City, MO (United States of America): **XV International People Plant Symposium and II International Symposium on Horticultural Therapies.** Info: Dr. Candice Shoemaker, 2021 Throckmorton, Department of Hort, Forestry, Rec Res, Kansas State University, Manhattan, KS 66506, United States of America. Phone: (1)7855321431, Fax: (1)7855326849, E-mail: cshoemak@ksu.edu

NEW

- October 19-24, 2020, Kunming (China): **XII International Symposium on Banana.** Info: Dr. Inge Van den Bergh, Bioversity International, C/O KULeuven, W. De Croylaan 42 bus 2455, 3001 Leuven, Belgium. Phone: (32)16377067, E-mail: i.vandenbergh@cgiar.org or Sijun Zheng, Beijing Load 2238, Kunming, Yunnan, 65020, China. E-mail: s.zheng@cgiar.org E-mail symposium: symposium@promusa.org Web: http://www.promusa-yaas.com/mtweb/en/
- October 25-28, 2020, Seoul (Korea (Republic of)): **III International Symposium on Germplasm of Ornamentals.** Info: Prof. Dr. Byoung Ryong Jeong, Department of Horticulture, 501 Jinju-daero, Gyeongsang National University, Jinju, Gyeongnam 52828, Korea (Republic of). Phone: (82)55-772-1913, Fax: (82)55-757-7542, E-mail: brjeong@gmail.com Web: http://www.isgo2020.org
- October 26-30, 2020, Malaga (Spain): **XIII International Mango Symposium.** Info: Dr. J. Ignacio Hormaza, EE. La Mayora - CSIC, 29750 Algarrobo-Costa, Malaga, Spain. Phone: (34)952552656, Fax: (34)952552677, E-mail: ihormaza@eelm.csic.es or Dr. Víctor Galán Sauco, Isaac Albéniz 17, 38208 La Laguna, Tenerife, Canary islands, Spain. Phone: (34)922261647, E-mail: vgalan46@gmail.com E-mail symposium: mango2020@ihsm.uma-csic.es Web: https://en.mango2020.es
- November 1-4, 2020, Lemesos (Cyprus): **III International Symposium on Soilless Culture and Hydroponics: Innovation and Advanced Technology for Circular Horticulture.** Info: Assist. Prof. Nikolaos Tzortzakis, Dept. Agricultural Sciences, Biotechnology, Food Science, Cyprus University of Technology, 3036, Lemesos, Cyprus. Phone: (35)7 25002280, Fax: (35)7 25002838, E-mail: nikolaos.tzortzakis@cut.ac.cy or Prof. Dr. Silvana Nicola, University of Turin, Dept. of Agric., Forest and Food Sciences, Leonardo Da Vinci 44 (L.Paolo Braccini, 2), 10095 Grugliasco (TO), Italy. Phone: (39)0116708773, Fax: (39)0112368773, E-mail: silvana.nicola@unito.it Web: https://www.hydro2020.com/

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